THURSDAY, NOVEMBER 27, 1890.

THE UNITED STATES CENSUS.

WE are surprised that so little attention is being given here to the totals of the United States census which are just being published. There is no more important record in the life of a people than its census. Accounts of progress are impossible without it. In the United States, also, special attention is given to the census, partly because it is a requirement of the Constitution, which assigns representatives to States and districts in accordance with the population figures. Every ten years, in the United States, there is a vast outlay on the business, with which outlay nothing spent in Europe can compare. But now there are loud complaints all over the United States that the record for 1890 is *wrong*; that the population of cities and places has been miscounted grossly. If these complaints are true, the United States might almost as well have had no census at all. All the elaborate work which is to be based on these population figures is rendered useless before it is begun Apart from the direct loss to the United States people themselves, who lose the information about their own affairs the census might have given them, the whole world sustains a loss in being deprived of comparisons of many kinds with so remarkable a progress as that of the United States. Has a colossal blunder, then, been made? and what can be the reason of it?

That there is a huge blunder, or worse, somewhere, appears quite unmistakable. Those who are interested have only to cast their eye over the following table to see that something unusual happened to the 1870 census, and has again happened to the 1890 census :—

Population of the United States, since 1800, *and increase in each decennial period.*

	Population (in thousands).	Increase.	
		Amount.	Per cent.
1800	5,308	—	—
10	7,239	1,931	36
20	9,634	2,395	33
30	12,866	3,232	33½
40	17,069	4,203	33
50	23,191	6,122	36
60	31,443	8,252	35½
70	38,558	7,115	23
80	50,156	11,598	30
90	62,481	12,325	24½

In all this long period the increase of population in the United States has been at the nearly uniform rate of a *third* every ten years, with the two exceptions of the 1870 census and the 1890 census, in which the increase is respectively 23 and 24½ per cent. only. What can have happened, first between the 1860 census and that of 1870, and next between the census of 1880 and that of 1890, to make the results so different from those of all the other periods?

Now, what happened between 1860 and 1870 is partially explainable. These were the years of the great Civil War, in which privation and disease, with death and injuries on the battle-field, had their thousands and millions of victims. Such causes are well known to check the growth of population. Unfortunately, also, there is another partial explanation. It has been admitted on the highest authority, that of General Walker, who supervised the census of 1880—and the admission is now repeated by the superintendent of the 1890 census—that the figures of the 1870 census were in some States falsified, with the result that in 1880, when the census of that year was taken, an impossible increase of population appeared to have occurred in those States. As far as *amount* is concerned, however, the former explanation has always been understood to be the more serious.

Can any such explanation be given of the small increase between 1880 and 1890? The answer is obvious. There has been no war or the like occurrence since 1880 to check the growth of population. There is absolutely nothing to suggest why the United States population, having increased most rapidly from the beginning of the century down to 1880, excepting during the war decade of 1860–70, should have suddenly had its rate of growth arrested.

More than this, the period between 1880 and 1890 has been one in which, according to past experience, owing to the special magnitude of the immigration, the rate of growth should have been as great as in any of the previous periods. The amount, and proportion to the population at the previous census, of the immigration into the United States since 1820, has been :—

Census period.	Amount.	Proportion to population at the previous census.
1820–30	128,000	1·3 per cent.
1830–40	538,000	4·2 ,,
1840–50	1,427,000	8·4 ,,
1850–60	2,814,000	12·2 ,,
1860–70	2,264,000	7·2 ,,
1870–80	2,707,000	7·0 ,,
1880–90	5,275,000	10·5 ,,

Thus, between 1880 and 1890, as far as the element of immigration is concerned, the growth of population in the Unites States was as much stimulated as in any previous decade, with the single exception of the 1850–60 period. There was absolutely no reason, then, why the rate of growth should fall off between 1880 and 1890, but a special reason why it should not fall off.

When we compare the figures in amount, we are still more bewildered. Between 1870 and 1880, with an immigration of 2,707,000 only, the increase of population is 11,598,000; so that, deducting the immigration, the increase which is due to the excess of births over deaths appears to be 8,891,000. Between 1880 and 1890, with an immigration of 5,275,000, the total increase of population is 12,225,000, and if we deduct the immigration, the increase which is due to the excess of births over deaths appears to be 6,950,000 only! The excess of births over deaths which was nearly 9,000,000 between 1870 and 1880 falls to less than 7,000,000 in the following decade, although the population at starting was 25 per cent. greater in the later than in the earlier decade. Making any reasonable correction for the under estimate in the 1870 census itself, which is now admitted, we still find these figures most startling. Even if we were to increase the population of 1870 to 40,000,000, as the superintendent of the 1890 census now suggests, thus reducing the apparent increase between 1870 and 1880 from about 9,000,000 to about 7,500,000, we should still be confronted by the fact that, starting from a larger population, and with a larger immigration, the excess of

births over deaths in 1880-90 would have been from 25 to 30 per cent. more than in the previous decade, or at least 9,500,000, whereas it appears to be under 7,000,000. The figures of the 1890 census are, therefore, quite incredible.

The superintendent of the 1890 census has issued an explanation, which does not, we fear, amount to very much. He makes a great deal of the errors in the 1870 census, which we have already glanced at, and asserts that the rate of growth of population, when proper corrections are made, was much less than 30 per cent. in the 1870-80 period, so that the rate of 24½ per cent. between 1880 and 1890 does not show a great falling off. But while he makes too much of the 1870 errors in amount, he makes no mention at all of the much larger immigration between 1880 and 1890 than in the previous decade, which should have made a difference of at least 3½ per cent. in the rate of growth in favour of the latter as compared with the former period.

A farther explanation is that there is a permanent tendency for the rate of growth of the population of a country like the United States to fall off. But this is not confirmed so far by any figures of a completely trustworthy kind, while the falling off in the rate of growth to be here accounted for is too great and sudden to be explained in such a manner.

The blunder is thus left quite unexplained, and the people of the United States, we may hope, will not fail to see to it. It concerns wider than merely national interests that the blunder should be seen to. For purposes of comparison, every census in the world is thrown out. Looking at the causes of the errors in the 1870 census, viz. an attempt to understate the numbers of the people in Democratic States, and at the special complaints of under-statement which have now come from New York and other Democratic centres, we have altogether too much reason to fear that the cause of the blundering is political. But, whatever the cause may be, it should be stringently looked into.

SPIDERS' WEBS.

American Spiders and their Spinning Work: a Natural History of the Orb-weaving Spiders of the United States, with Special Regard to their Industry and Habits. By Henry C. McCook, D.D. Vol. II. pp. 1-479, with 5 Coloured Plates and 401 Woodcut Figures. (Philadelphia: Allen Lane and Scott, 1890.)

IN a notice of vol. i. of the above work (NATURE, vol. xlii. p. 244), its object and scope were explained. Vol. ii., now before us, fully justifies what was there stated as to the thoroughness with which the available materials on the subject have been brought together from all sources, and for the first time presented to the world as a whole. A similar popular treatment also of this interesting and most important part of the subject is again here observable. Vol. i. was occupied with the snares and web-spinning of orb-weaving and some other spiders, principally in relation to the getting of their livelihood. Vol. ii. treats of these spiders in respect to the propagation of their kind, and web-spinning as subservient to this. Vol. i., in fact, presents us with spiders safely arrived at maturity, and forming their snares and webs with all the diversity and perfection peculiar to each species; while vol. ii. takes them up at that point, and shows them to us in all the different peculiarities pertaining to the performance of the ultimate object of their existence. Naturally, therefore, the volume before us begins (part i., chapter i.), with an account of the sexes in their relation to each other preparatory to actual pairing. This latter and the points arising out of it form the staple of chapters ii. and iii., which complete part i. A certain air of sentimental allusion, which appears to pervade the author's method of presenting this part of his subject, is perhaps merely a matter of taste, and so beyond the province of scientific criticism. It may be, however, that this, while it certainly adds nothing to scientific accuracy or progress, does add to the popularity of the subject, which is evidently throughout the work one of its author's great objects. On the small size of many male spiders compared with their bulky females, Dr. McCook does not appear to accept the views of a former writer upon it, in which it should be observed that the primitive equality in the size of the sexes is by no means implied; the general rule being that the male is the smaller of the two. But if it be granted that the female had a propensity for attacking and devouring the male, those males which happened to be the smallest and most active would be the most likely to escape, and perform the functions of the sex; natural selection would then come in, and operate gradually in the direction of lessening the size of the males. That there are numerous spiders, and groups of spiders, in which the sexes are nearly equal in size, or live in amity together, or in which the males are furnished with some protective armature against the ferocity of the female, proves nothing against the theory of the action of natural selection in lessening the size of the male in such cases as those where a devouring propensity existed and was otherwise unprovided against; for in groups where any approach to equality in size existed and became protective, or where some other protection became developed, there would be no need, in fact no case, for natural selection in the direction of diminished size, there being no advantage to be gained under it. The drift, however, of the author's reasoning on this subject (p. 7) is not very apparent.

Part ii. treats of the "Maternal Industry and Instincts of Spiders"; embracing the formation of cocoons for the reception of their eggs, and the bringing into existence of the young, which naturally leads (part iii.) to the consideration of the life of the young while still engaged in the struggle for existence necessary for the survival of the fittest. The dispersion of spiders on the approach of maturity leads to an account of their method of locomotion on gossamer lines and flakes, completing part iii.

Part iv. enters into the subject of the senses of spiders, and their relation to habit. The structure of the eyes, and their functions are gone into in considerable detail. The remarkable position of these organs in the males of some species—such as *Walckenaera acuminata*, Blackw., in which they are seated near or at the top of a very long slender kind of footstalk—is mentioned; and it is supposed (p. 298) that this might give the male spider an advantage when in search of the female; but, apart from this explanation not being warranted by any known facts as to the

habits of the spider, it would seem to be well enough accounted for as the result of excess of vigour or vital force belonging to the stronger or male sex. The action of natural selection would operate here also, indirectly, and these and other similarly excessive developments would only be checked when they tended to become, or became (as in some cases they indeed appear to have nearly become), positively detrimental, or at any rate disadvantageous, to the sex. The senses of spiders—"smell," "hearing," and "touch"—are then gone into. In connection with the sense of "hearing," various stock stories about spiders and the effect of musical sounds upon them are detailed; but such small credit is attached to them as relating facts on which any scientific conclusions can be based, that it would hardly seem to have been worth while to swell an already bulky volume by their repetition. Chapter x. of part iv. ends with the details of the stridulating power of some spiders and its probable purpose. Chapter xi., on the colour, and colour-sense, brings part iv. to a conclusion. The more brilliant colouring and ornamentation of the male spider, in some groups, is accounted for by the preference supposed to be given on the part of the female to males thus ornamented. But it does not appear that this preference is yet proved in any instance as a fact; nor can it be fairly argued that, because sexual excitement often leads the male to display it in curious antics and contortions, it therefore follows that the female is in the least influenced by it; whereas in fact, as she is stated to be (p. 63), the female is generally an unmoved spectator. Doubtless the male frequently succeeds in his purpose after such displays—*post hoc* certainly, *sed non propter hoc*. The author having come to the conclusion that the female prefers the male for his bright colours, we are not surprised to find it argued, conversely, that in those groups where it is the female sex which is the largest and bears the brightest hues, it is the less gaudy male who is helped and influenced in his choice by the increased size and excessive coloration of the female. The argument here also does not appear to have more real weight than in the former case, if even so much. On the subject of adaptation of the colouring of spiders to their surroundings and its beneficial effect, the opinion is expressed that, considering the great exposure to enemies of numbers of brilliantly coloured and conspicuous spiders, no generalization is yet warranted. No weight seems here to be given to the supposition that some of these exposed spiders may be distasteful as food; while it is admitted that many, as those of the genera *Gasteracantha* and *Acrosoma*, are protected by their spiny armature, and, it may be added, by their generally hard integument. The theory of "warning colours" is dismissed as inapplicable to spiders. Adopting the experiments of Sir John Lubbock and Mr. and Mrs. Peckham, spiders are considered to possess a sense of colour; but when we are told that a test case was afforded by a spider whose eyes had been purposely blinded with paraffin, our confidence in the result of these experiments will perhaps be a little shaken; since it is gravely argued from this test case that, because a blind spider exercised no apparent choice of one colour over another, this proves that the apparent preference of a spider before blinding was a true choice, and that there exists a colour-sense in certain spiders. Chapter xii. of part v. is on that most interesting part of natural history in all its departments—resemblance to other objects both inanimate and animate, with the causes and consequences of the resemblance. Space will not permit us to follow the author in the details of this part of his subject. The chapter will be read with pleasure and interest by most observers; but we may perhaps remark that there is at times an apparent tendency to take inability to perceive any resulting advantage from the resemblance as a proof that the resemblance is not the result of natural selection.

Chapter xiii. of part v. treats of the enemies of spiders, and their influence on habit. This subject is, of course, closely connected with protective resemblance; and by no means the least interesting part of this chapter is the account of some truly parasitic spiders—*Mimetus interfector* and others. These take up their abode in the webs of other spiders, and after eating the rightful owner, regale themselves at leisure upon its eggs and young. Part v. ends with chapter xiv., on "Death and its Disguises; Hibernation, and Death feigning." Natural death may be almost said to be an unnatural event in the history of most of the creation, excepting man; but perhaps more frequent instances of it are seen by the entomologist and araneologist, than by other naturalists. Some of our British *Drassidæ*, in the genus *Clubiona* for instance, may often be found sewn up in a nest of leaves drawn together, with their egg-sac, brooding over it, in various stages of lethargy, sometimes so shrivelled and comatose as to be almost incapable of movement. These spiders probably drop to the earth with the opening of the nest for the exit of the young, and at once die when their progeny begin to live. The author gives interesting details of a similar kind in reference to spiders of the family *Epeiridæ* far removed from the *Drassidæ*, and we have also noted it in another family equally remote from both, *Thomisidæ*. "Death feigning" is considered to be perfectly voluntary, though perhaps developed out of an original state of "fright-paralysis"; contrary to the opinion and explanation given by Darwin of this habit. The concluding part of the book, part vi., contains an account of fossil spiders, a subject which, though bearing very little upon the "spinning work of spiders," has a very strong and an increasing interest of its own. It appears to be well treated in the twenty-three pages here devoted to it. We cannot leave this necessarily very incomplete notice of Dr. McCook's bulky volume without drawing especial attention to the numerous (401) woodcuts, and the coloured plates, with which it is so profusely and usefully illustrated. The greater part of these are engraved from the author's own original drawings, and evidence a skill as well as a power of patient observation scarcely equalled in any contemporary work on natural history.

O. P. C.

MR. BASSET'S ELEMENTARY TREATISE ON HYDRODYNAMICS AND SOUND.

An Elementary Treatise on Hydrodynamics and Sound. By A. B. Basset. (Cambridge: Deighton, Bell, and Co. London: George Bell and Sons. 1890.)

WHEN the Senate of the University of Cambridge decided to adopt the suggestion of the Special Board for Mathematics to include the elements of hydro-

dynamics and the theory of sound among the subjects of Part I. of the Tripos, teachers of these subjects naturally looked to Mr. Basset to provide a text-book that should meet the wants of students preparing for the examination, and he has responded to the demand with great promptitude. The present treatise is designed, he tells us, for those who are reading for this examination and others in which a knowledge of these subjects is required. If the purpose of the book had been different—if, for instance, it had been written as a purely scientific training for hydraulic engineers, or for use in a physical laboratory—it would have had to be conceived in a very different vein. We should have looked for full explanations of elementary concepts, frequent appeals to experiment, constant arithmetical interpretation of the analysis, and a large proportion of physical reasoning. If, however, the book is to be judged by the standard it aims at, it must be regarded as an admirable specimen of an examination book. The propositions are clearly set out in a methodical order. They are isolated from each other as much as possible, and proved individually by the use of appropriate principles. The examples are for the most part well chosen, and calculated to initiate the student into a great variety of the tips and dodges with which the examiners are likely to be familiar; and no more is generally given than would be useful in writing out book-work and solving problems.

We proceed to a detailed account of the work.

The treatise is divided into two parts, of which the first deals with hydrodynamics, and the second with the theory of sound. In the first part there are five chapters. Chapter i. treats of the kinematics of fluids and of the general equations of motion. We are glad to see that the author has given prominence to the "flux method," and has had the courage to restore the elementary parallelepiped which Prof. Greenhill affects to despise; for the purposes of an elementary treatise the value of this artifice is too great to be lost. Very welcome also is the proof of the important principle at the foot of p. 11, first stated exactly in the larger treatise, vol. ii. p. 234, and apparently due to Prof. Greenhill ("Encyc. Brit.," Art. "Hydromechanics"). We could wish that the theory of the bounding surface had been as fully explained. The same chapter i. contains a short account of sources, doublets, and images, and electric and magnetic analogies are given which add much to the usefulness of these sections.

Chapter ii. treats of the motion of a sphere and of the motion of certain cylinders in an infinite fluid. The descent of the sphere under gravity is very nicely worked out, the usual ambiguity being avoided by explicitly introducing the distance of the centre from a fixed horizontal plane. The resultant pressure on the sphere is calculated, and the equations of motion deduced from Newton's second law. The chapter concludes with an interesting account of the resistance of a liquid to the motion of a spherical pendulum. This chapter contains an exception to the general plan of the work. Mr. Basset appears to write hydrodynamics *con amore*, and cannot always be restrained from trying to teach the student something which he will not be called upon to write out. We refer to his account of recent researches in the theory of the resistance of viscous fluids.

Chapter iii. is occupied with the theory of the motion of a single solid in an infinite liquid. This part of the subject is less elementary than the others which are treated in the book, inasmuch as the machinery of moving axes has to be introduced. The author has cleverly avoided the use of Lagrange's equations and Routh's method of ignoration of co-ordinates, but it must be confessed that it is sometimes a little difficult to see how some of the terms in the equations are obtained by means of the principles invoked. The student may well be puzzled to account for the term $-M'g$ in the equation of motion of the sphere on p. 69. The most interesting problem discussed in the chapter is that of the motion of an elliptic cylinder. Drawings of the path of the centre of gravity in the three cases of oscillation, revolution, and just complete revolution, are given. In the first case, the path looks something like an orthogonal projection of a curve of sines, and the cylinder moves so as to have turned through the maximum angle when the centre is at an inflexion; it then turns back, and the angle described goes through a periodic oscillation while the cylinder moves over a wave-length. In the second case, the path looks like a nodal trochoid, and the cylinder makes one complete revolution in the time taken to pass from a node to the next consecutive node but one. In the third case, the path looks like a nodal cubic with an inflexion at infinity. The cylinder moves from infinity with its major axis initially parallel to the asymptote; at the furthest extremity of the loop it has turned through a right angle, and it then goes off to infinity in the opposite direction, and only turns through two right angles in the whole length of its path. Other interesting things in the chapter are the application of the theory of helicoidal steady motion to explain the necessity of rifling guns, and the theory of the motion of a cylinder in a fluid bounded by a fixed rigid plane, leading to the suggestion of the realization of "action at a distance" by means of fluid pressure.

Chapter iv. is devoted to liquid waves. All the elementary problems are treated very elegantly. "Long waves" are in the first place regarded as a particular case of progressive harmonic waves, and the "exact theory" of long waves in a canal comes afterwards. This seems to us the most natural order. Another point of interest is the discussion of a case of instability, due to Lord Rayleigh. Mr. Basset has done well all through to insist upon the importance of investigations relating to stability.

Chapter v. is occupied with the theory of rectilinear vortices. The vortex line is treated as an ideal limit of a vortex cylinder, and some cases in which the cylinder is of finite section are discussed. We think it unfortunate that in treating the elliptic vortex cylinder the value of the constant D is not given, as it is directly proportional to the circulation; but the student reading the section is certain to take it to be an arbitrary constant. The simplest cases of motion of a straight vortex in a bounded space are treated by the method of images. The chapter concludes with new proofs of Helmholtz's celebrated "laws of vortex motion." A brief account of Sir W. Thomson's theory of "vortex atoms" would have been of interest here.

Part ii. of the treatise deals with the theory of sound, and contains five chapters. The first of these (chapter vi.) is intoductory, and explains the relation of musical notes to the vibrations of bodies, and the connection be-

tween sound and the propagation of waves in air. It is admirable rather for conciseness than for completeness of exposition.

Chapter vii. is occupied with the vibrations of strings and membranes, nearly the whole of it being devoted to transverse vibrations of strings. The method of acoustics is adopted, as developed in Lord Rayleigh's treatise. It consists in assuming the motion to be periodic, and dependent upon a function called a normal function, in a series of which arbitrary functions can be expanded. Mr. Basset has changed the nomenclature, so that the "normal co-ordinate" of Lord Rayleigh is here called a "normal function." Is this intentional? The method adopted dispenses with the necessity of proving Fourier's theorem. Other things in this chapter worthy of note are the formation and discussion of the equation of motion for a string subject to viscous resistance and under the action of a periodic force, leading to a particular illustration of the well-known theory of forced vibrations.

Chapter viii. is occupied with the theory of the vibrations of bars. It opens with an account of the stress in a bent bar, and we have here the first hint in an English book on acoustics of any difficulty in that subject. In a footnote Mr. Basset clearly states the nature of the assumption usually made, and further expresses his conviction that it is not rigorously true, describing the character of the change in the equations of motion if a more exact theory were adopted. It is a good thing to have mentioned this. The rest of the chapter is devoted to the lateral vibrations of bars. The differential equations are obtained by the use of the stress equations, the idea of the method of formation being taken from a paper by Dr. Besant, and the frequency equations are given for the various cases of ends supported in different manners. Although, perhaps, a discussion of them may be beyond the purpose of the book, we cannot help thinking that a few numerical results would assist in the comprehension of the subject

The two last chapters deal with the theory of waves in air. Chapter ix. contains the formation of the differential equation of vibrations, and a discussion of the value of the velocity of sound as given by Newton and Laplace's suppositions respectively. To explain the latter an account is given of the thermodynamics of gases, leading to the relation of pressure to density when the changes are isentropic.

Chapter x. contains an account of some of the simpler problems of plane and spherical waves. We find here the theory of the notes in a doubly closed pipe, and a short discussion of the forced vibrations produced by attributing an arbitrary periodic motion to a disk at one end of the pipe. The interest of vibrations in pipes lies rather, as it seems to us, in the cases where the pipe has one or both ends open. Even when these are treated as "loops," something may be done towards a theory of organ pipes. The relation of the notes in a "stopped" to those in an "open" pipe is not even given as an example, nor do we find any account of the interesting problem of reflexion of waves in a pipe at the stopped or open ends. The next subject treated is the reflexion and refraction of plane waves at a surface of separation between two gases; this is very nicely worked out, the equations and conditions being very clearly given. The rest of the chapter is occupied with spherical waves. We have here Lord Rayleigh's solutions for (1) purely radial disturbance within a rigid spherical envelope; (2) the vibrations in a conical pipe; (3) the resistance of the air to the motion of an oscillating sphere, and the theory of the scattering of plane waves by a small sphere. The last problem, as here solved, requires the expansion of the velocity potential in a series of spherical harmonics —the only instance in the book of the use of these functions.

The book is well printed and nicely bound. The few blemishes we have had occasion to notice will not seriously diminish its value, and Mr. Basset is to be congratulated on having produced a work that certainly ought to achieve success. A. E. H. L.

LOWNE ON THE BLOW-FLY.

Anatomy, Physiology, Morphology, and Development of the Blow-fly (*Calliphora erythrocephala*). Part I. By B. Thompson Lowne, F.R.C.S., F.L.S., &c. (London: R. H. Porter, 1890.)

MR. LOWNE'S new work on the blow-fly, of which Part I. has just appeared, requires the serious attention of all who occupy themselves with insect anatomy. It contains the results of a diligent and protracted inquiry, and will teach even specialists a good deal which they did not know before.

Mr. Lowne has written before on this subject. His earlier book (1870) on the blow-fly was the manual of what we may now call a past generation of insect-anatomists, who studied it zealously, and, we fear, often got hopelessly puzzled with its many difficult passages. The present publication is not a new edition, but a totally new work, and the author has only thought it worth while to mention his earlier memoir quite casually in one or two places. The interval of twenty years has enabled Mr. Lowne to make great advances in the knowledge of his subject, and his old treatise on the blow-fly may now cease to be read.

This increase of knowledge is due to laborious microscopic investigation, and to a lengthy, though not exhaustive, study of a literature which is copious, technical, and very largely German. The student has to thank the painstaking author for many new facts, and also for a good deal of information, which, though not new, was previously accessible only to specialists.

Perhaps the most interesting remarks which we have found in Part I. relate to the imaginal disks (it would be better to call them imaginal folds), those curious inward growths of the larval epidermis from which nearly the whole body of the fly is ultimately fashioned. Mr. Lowne's account should be carefully examined by those who have hitherto been content with text-book information, or the descriptions of Weismann, which, original and brilliant as they were, required rectification on a number of special points. We can look forward to a discussion of these imaginal folds far more interesting, and at the same time simpler, than any that present knowledge has produced. Such a type as Corethra (which, by the way, is misquoted as Chironomus in the note to p. 77) shows a slight telescoping of the imaginal antenna within the larval head. Other types, as yet

imperfectly described, exhibit deeper and more complex invaginations, while the Muscidæ form the extreme term of the series. At this moment we want above all *comparative* studies, and till they are supplied, minute descriptions of highly special cases are hardly intelligible. Few biologists seem to be aware of the interesting research which lies open to any competent student in a well-selected series of Dipterous larvæ and pupæ. It will ultimately be necessary to include other insect-orders, for imaginal folds are not peculiar to Diptera. Many Lepidoptera are instructive in this connection. Pieris, for example, as J. Dewitz (*Biol. Centralblatt*, Bd. iii. p. 582) points out, exhibits that connection between the sutures of the clypeus and the antennary folds which the author (quoting Mr. Hammond) has noticed on p. 43. The subject is not sufficiently worked out for popular treatment, and the beginner who takes up Mr. Lowne's account of the development of the fly has many a hard nut to crack.

The new work contains many interesting particulars concerning the life-history and minute structure of the blow-fly; there are not a few useful figures, and the bibliographical references are tolerably extensive. If the succeeding parts are equally full of matter, the treatise will make a really considerable addition to our knowledge.

Nevertheless there are some faults to be pointed out. The arrangement of the matter is not always convenient or luminous; see, for example, the place (p. 12) chosen for the definition of an insect and the definition of morphology. Now and then an ill-considered remark, perhaps having no close connection with the subject in hand, distracts or misleads the reader. Why should the author go out of his way to speak of mammals, birds, and reptiles as "separate and divergent genetic series" (p. 26), a proposition by no means so evident that it can be thrown in as a passing illustration! Surely Mr. Lowne, by thinking twice, would have saved his readers from puzzling over that strange remark (p. 7) that in all insects (this is apparently the sense) there is no cœlom or "distinct continuous body-cavity."

We shall await with much curiosity the promised proof of the hepatic function of the Malpighian tubules. Meanwhile we can only wonder in what sense the author uses the word *hepatic*. We shall also be glad to learn the reasons for believing in a "metenteron," as defined on p. 17.

No one interested in insect anatomy is likely to adopt all Mr. Lowne's views, but no such person can hesitate to admit that he offers us a substantial contribution to his favourite subject. L. C. M.

OUR BOOK SHELF.

A Treatise on the Diseases of the Sheep; being a Manual of Ovine Pathology especially adapted for the use of Veterinary Practitioners and Students. By John Henry Steel. (London and New York: Longmans, Green, and Co., 1890.)

SHEEP and their diseases have had but little attention from the veterinary profession, and consequently this work, just published by Mr. J. H. Steel, one of the most astute and successful veterinary practitioners and teachers of the present day, must be looked upon as the result of an important step in the right direction. Though we admit the author's ability and the probable usefulness of the book, yet the most conspicuous feature connected with it is the evidence which it gives of how very little of a sound, practical, and useful nature is known by scientific men in relation to sheep. No claim is made to originality in the subject-matter produced, and indebtedness to the various authorities quoted is freely acknowledged. There is, however, a distinct want of discrimination between those who are the leading authorities on certain subjects and those who are not. One who could write the three names, Walley, Williams, and Gamgee, in the order presented, shows he has no regard for precedence in virtue of merit. Gamgee in his day was perhaps the greatest genius who had ever adorned the veterinary profession, and Williams is unquestionably the most successful living author of veterinary works of a high order. Errors of an extraordinary kind appear where the writer, who is not himself familiar with the subject, attempts to enlarge upon the statements of others from whom he quotes; for example, in writing of the tick, ked, or fag (*Melophagus ovinus*), he says "the animal buries its head and proboscis in the skin, and once fixed hangs on for months. It is nimble and active, and sometimes as large as a horse-bean." Any entomologist familiar with sheep cannot fail to see that the author has mistaken the grass-tick (*Ixodes*) for the sheep-tick (*Melophagus*), which belongs to a different genus, and has confounded the habits of the two creatures in an extraordinary manner. Apart from errors of this kind the work is far from complete, but if due care were taken to correct mistakes and to consult as additional references such recent works of a superior kind as "The Animal Parasites of Sheep," by Dr. Cooper Curtice, published at Washington by the United States Government during the present year, the second edition might be made a most serviceable, interesting, and valuable volume.

Wild Beasts and their Ways. By Sir Samuel W. Baker, F.R.S. Two Vols. (London: Macmillan and Co., 1890.)

NO one who has read any of Sir Samuel Baker's books of travel will need to be told that he has all the instincts and aptitudes which, under favourable conditions, make a man an eminent sportsman. He is, however, much more than a sportsman; as he himself says, he has never hunted without a keen sense of enjoyment in studying the habits of the animals pursued. In the present work he records some of the experiences he has had in various parts of the world, and students of natural history will find in his narrative much that cannot fail to interest them. The book is not, of course, in the strictest sense scientific; but it has points of contact with science, and these will make it as welcome to zoologists as it is sure to be, for other reasons, to general readers. Sir Samuel confines himself to wild animals which he himself has had opportunities of watching, so that all the incidents and scenes he brings before us have that kind of freshness and vividness which can belong only to descriptions that embody the results of direct personal observation. The work is admirably illustrated by reproductions of drawings prepared by Mr. Dixon.

Properties of Matter. By P. G. Tait. Second Edition. (London: Adam and Charles Black, 1890.)

THIS is a revised and considerably extended edition, and the author has paid special attention to points in connection with which difficulties had been found. Among the more important additions are the results of some of M. Amagat's splendid and hitherto unpublished work relating to the compression of liquids exposed to enormous pressures. This in itself, when completed, will, as the author remarks, "form a singularly interesting and practically new branch of the subject."

Our Fancy Pigeons. By George Ure. Cheap and Enlarged Edition. (London: Elliot Stock, 1890.)

THE title of this book does not give quite an accurate idea of the contents, for in the first part there is a good deal about fishing and things in general, and the third is a collection of "rambling ornithological notes." In the second part, however, the author deals systematically with the pouter and other "high-class breeds," and offers some remarks on minor varieties of fancy pigeons. Mr. Ure is a lively writer, and his facts and opinions are presented as the results of long-continued personal study and experiment.

Alexis and His Flowers. By Beatrix F. Cresswell. (London: T. Fisher Unwin, 1891.)

THIS pretty volume is intended for boys and girls, and, as it is brightly written, ought to be read by them with pleasure. It contains much quaint and interesting "flower-lore."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Dr. Romanes on Physiological Selection.

IN his two latest articles dealing with this subject, Dr. Romanes has made certain statements as to my position in regard to it which call for a brief notice on my part.

In his original paper, and in the summary of it published in NATURE, Dr. Romanes adduced variations in regard to fertility and sterility as the fundamental fact in physiological selection. A few quotations will show this. He says: "It becomes almost impossible to doubt that the primary specific distinction (meaning sterility) is, as a general rule, the primordial distinction" (NATURE, vol. xxxiv. p. 339). Again, he enforces this as against Darwin's view that sterility was a consequence or concomitant of other differences, as follows: "My theory, on the other hand, inverts this order, and supposes the primary distinction to be likewise (in most cases) the primordial distinction" (*l.c.*, p. 363). This is very clear, but to show that he limited the term "physiological selection" to the results supposed to arise from this phenomenon, we have his reply to Mr. Galton, who urged a fact also dwelt upon by Darwin—the psychological disinclination to mate between many varieties—as an important factor in the differentiation of species: "Now I have fully recognized this principle as one amongst several others which is accessory to, although independent of, physiological selection" (*l.c.*, p. 407). A little further on he again states his fundamental fact thus: "If my theory is true, it must follow, as Mr. Galton says, that such unions would be more or less sterile, and, as this sterility is itself the only variation which my theory supposes to have arisen *in the first instance, ex hypothesi* we can have no means of observing whether or not the individuals which present this variation 'consort with outsiders,' or with those individuals which do not present it" (*l.c.*, p. 407). As if to leave no possible doubt as to the special point of his new theory, he again enforces it in the following passage: "And forasmuch as the sexual separation arises only by way of a variation locally affecting the reproductive system, when the variation is first sexually separated, it will in all other respects resemble its parent stock, and so be able to compete with it on equal terms" (*l.c.*, p. 408).

Now surely all this makes it absolutely clear that Dr. Romanes's theory of physiological selection, so far as it had any originality, was founded on the supposition of sterility-variation alone, arising in an otherwise undifferentiated species; and he claimed that such variations "cannot escape the preserving agency of physiological selection," and that "physiological selection must be quite as vigilant as natural selection, and it seizes upon the comparatively unuseful variation of sterility with even more certainty than natural selection can seize upon any useful variations" (*l.c.*, p. 364).

These last statements, by the truth of which alone the use of the term "selection" can be justified, I showed by two carefully considered cases to be absolutely unfounded, and the exact opposite of what must really occur (*l.c.*, p. 467; and "Darwinism," p. 182). Having thus proved that "physiological *selection*," in the only form claimed by Dr. Romanes as original, does not exist, and that the only modes by which degrees of sterility between distinct species can arise are those discussed or suggested by Darwin himself, with the addition of the possible action of natural selection in increasing incipient sterility between slightly differentiated forms, will it be believed that I am accused of having appropriated the theory of physiological selection without acknowledgment! In the *Nineteenth Century* (May 1890, p. 831), Dr. Romanes says of me: "He presents an alternative theory to explain the same class of facts. Yet this theory is, purely and simply, without any modification whatsoever, a restatement of the first principles of physiological selection, as these were originally stated by myself." And now, in the October issue of an American magazine, *The Monist*, he has an article entitled "Mr. A. R. Wallace on Physiological Selection," in which the original main point, of sterility-variations alone leading to and constituting "physiological selection," is almost entirely ignored, and the various modes by which isolation is produced between incipient species or in which infertility arises in correlation with other divergent characters, are all claimed as forming part of the theory of physiological selection. He quotes from "Darwinism" my exposition of the effects of partial infertility arising between "two varieties in process of adaptation to somewhat different modes of life within the same area," to show "how unequivocal and complete is Mr. Wallace's adoption of our theory" (*The Monist*, No. 1, p. 11). "Our" refers to Mr. Gulick, who is taken into partnership by Dr. Romanes. And again he speaks of "the peculiar position to which he has eventually gravitated with reference to my views—professing hostility on the one hand, while reproducing them as original on the other" (*l.c.*, p. 19).

I have here confined myself to showing, by Dr. Romanes's own repeated and emphatic statements, what was the essential and original theory to which he gave the name of "physiological selection." The whole of this special doctrine I have argued against as unsound, because, on close examination, it proves to be quite inadequate to produce any such effects as are claimed for it. Whether I was right or wrong in doing so, I did, as a matter of fact, and do still, wholly reject this fundamental and essential part of the theory—the only part which had even a *primâ facie* claim to originality. I also totally reject the two subsidiary doctrines on which Dr. Romanes lays great stress as adjuncts of his theory—that of the inutility of a large proportion of specific characters, and that of the power of isolation alone "without the aid of natural selection" to produce new species; while, so far as I know, the only points in which I agree with him are those in which we both make use of Darwin's facts and adopt Darwin's explanation of them. Yet, notwithstanding this rejection of all that is special in his teachings, Dr. Romanes has the hardihood to assert that I claim them as my own; that I merely restate his theory "purely and simply, without any modification whatsoever"; and that my adoption of his theory "is unequivocal and complete."

I leave it to others to characterize these extraordinary statements in the terms that fitly apply to them.

ALFRED R. WALLACE.

Attractive Characters in Fungi.

I NOTE in your issue of November 6 (p. 9), Mr. Straton mentions the fact of the common mushroom spores being unproductive until they have passed through an animal host, naming horse, sheep, and oxen, but it appears to me it must be rendered equally fertile after passing through the larvæ of beetles, flies, &c., else how could nurserymen supply spawn with mycelium ready for generation? It is possible, therefore, that though larger animals act very often as hosts to mushroom spores, insects are mainly responsible for their reproduction. The soft spongy nature presents but little resistance to the ovipositor, and most mushrooms if examined in a state of decomposition will be found perforated by maggots, the larvæ of Diptera and Coleoptera.

It is possible that a sustained high temperature is necessary to the first stage of development in fungi, which is admirably attained in the living host, but it is probably immaterial whether the mycelium is developed on the excreta of mammal or insect. Heat is evidently a great factor even in the second stage of germination, as the so-called "spawn" will remain dormant for

a long period unless it is applied. I well remember a peculiar case in point. A wild hill-top covered with gorse and bracken was to be taken into cultivation; it had been unturfed, the turves and gorse being piled in heaps and burned on the ground (many acres in extent) now ready for the plough. It was in the month of August. While these heaps were still smouldering, there came two days of heavy rain; immediately after, sprang up like magic an immense crop of mushrooms, chiefly close to the ash-heaps. They were unusually large, and the tops were very brown—scarcely to be distinguished from the bare earth they grew on.

These germs must have been gradually collecting under the turf for years, beaten in by the weather, the moss slowly growing over and hiding them from the air and heat. The removal of the turf exposed them, when, forced by the extraordinary heat of the burning heaps, they suddenly sprang into existence. In after years, when the ground was under cultivation, they were seen no more, for the reason, probably, that when the plant-life was all destroyed, a great part of the insect-life went with it, and thus the means of propagation was lost.

Biarritz, November 23. R. HAIG THOMAS.

P.S.—I have never actually seen cattle or horses eat mushrooms, but that goats certainly eat some kinds of fungi I can state positively, as last year, in Norway, I had an opportunity of personally observing the fact. A party of us were walking through the pine forest; one of the peasants was leading a goat down the mountain from a *saeter* to his farm below. My companions called me to look at the goat, which had stopped in the pathway, and was greedily nibbling at a large piece of sponge-like fungus, such as one finds commonly in the woods. She speedily ate it all up. We expressed some surprise, but the peasants told us goats were very fond of and often eat fungi.—R. H. T.

As stated by Mr. Cooke (NATURE, November 20, p. 57), there is an apparent contradiction between the impossibility of finding out some process of "impregnation" previous to the formation of the spores in Hymenomycetes, and, on the other hand, the occurrence of forms suspected to be "hybrids."

A very remarkable statement in De Bary ("Morphol. u. Physiol. der Pilze," § 1, p. 2), however, may perhaps afford a clue to the mystery, viz. the occurrence of amalgamations between hyphæ originally produced from distinct spores. Might not such a process as this possibly lead to "hybrids," if those spores belonged to distinct species? W.

Freiburg, Badenia, November 22.

I WAS shown the other day, in a wine cellar, completely excluding light and fresh air, a remarkably beautiful growth of fungus, covering the wall and floor, to a depth of 4 inches in places, and suggesting cotton-wool in form and colour. When taken up and pressed, it turned brown and emitted the characteristic fungus smell. I should be glad to learn the name, and whether the pure white of the fungus is due to the total exclusion from light. M. H. M.

Doppler's Principle.

THIS subject was referred to in NATURE some months ago, but, although the question is comparatively simple, there is one point of some importance which was not then brought out and to which I have never seen any reference. The change in pitch is, of course, due to the change in the rate at which the cycles of disturbance which constitute the wave-motion fall upon the ear. To determine this change of rate, it is necessary to consider (1) the space occupied by each cycle; (2) the relative velocity of the wave-motion and the observer. Consideration (1) is connected with the velocity of the source of sound, and if wave-length be defined as the shortest distance between two vibrating particles in the same phase, then the space occupied by each cycle may be called the wave-length. If, however, wave-length be defined as the distance which the wave-motion travels through the medium during the "period" of vibration of the sounding body, then the wave-length so defined is unaffected by the motion of the sounding body. It is in connection with this point that there is generally some ambiguity in the usual terms of explanation.

Let s denote the position of the sounding body, and o that of the observer. If a denote the velocity of the observer, a' the velocity of the sounding body, m that of the medium, and v the velocity of sound, then during the "period" of the vibration of the sounding body the disturbance travels, *through the medium*, a distance $\frac{v}{n}$, where n is the frequency of the vibration. During this period, however, s is displaced to s, a distance $\frac{a'}{n}$; and, owing to the motion of the medium, the disturbance originally starting from s, although traversing a length $\frac{v}{n}$ through the medium, only reaches a point a at a distance $\frac{v-m}{n}$ from s. The distance, $sa = \frac{v+a'-m}{n}$, is thus the actual distance between two particles in the same phase, or gives the *effective* wave-length.

The velocity of the motion through the medium is v, and therefore its velocity relative to o is given by $v+a-m$. Hence, in one second, the number of effective wave-lengths which fall upon the ear is expressed by

$$n' = \frac{v+a-m}{v+a'-m}n.$$

That is, the pitch of the note heard at o is given by n'. This is the formula given by Prof. Everett in NATURE, vol. xlii. p. 81.

Cambridge, November 18. R. W. STEWART.

The Comb of the Hive-Bee.

IN a recent article the Bishop of Carlisle puts forward, as conclusive objections to the perfecting of the cells in the comb of the hive-bee by natural selection: (1) the fact that other kinds of bees continue; (2) that the sterile workers cannot transmit favourable variations.

But (1) other bees, however inferior in comb-making, may have advantages in other respects; thus the humble-bee can reach the nectar of flowers that are not accessible to the common hive-bee. (2) Favourable variations in the workers would presumably or possibly appear in the further swarms thrown off from the hive or home from which these proceeded; and further, seeing that the workers are really females, the queens in the swarms so thrown off may inherit and transmit the favourable tendency. WM. KNIGHT.

Savile Club, 107 Piccadilly, W., November 22.

A Swallow's Terrace?

MR. A. G. VERNON HARCOURT has just shown me, in his boat-house at Cowley Grange, a specimen of swallow's architecture unlike anything I have seen or heard of. The nest, which is itself normal, is placed at the end of a small beam extending from the top of the door to the angle of the building. This beam is about two feet and a quarter in length, and four inches broad. The nest is at the end next the door; the whole of the rest of the surface of the beam is occupied with an adjunct to the nest, which looks as if it had been meant for the family to perch and roost on. It consists, like the nest, of a foundation of dried mud, carefully covered with dry grass; and it is obvious that much care and pains were spent on its construction. Its length (excluding the nest) is nearly two feet.

Mr. Harcourt thinks that the nest was built late last summer, but he did not notice it then, or discover the use of this curious terrace. Can any of your readers parallel or explain it?

W. WARDE FOWLER.

Lincoln College, Oxford, November 20.

Araucaria Cones.

IN answer to the Duke of Argyll's inquiry respecting the coning of the *Araucaria imbricata* in the British Isles, I beg to state that there have been, within my own cognizance, several instances of the same during the last thirty or forty years in this country, notably at Maresfield in Sussex, at Bicton in Devonshire, and especially at Chatsworth. The famous avenue of them at Chatsworth frequently produced cones during the last ten years of the trees' existence prior to 1860, when the memorable severe frost on Christmas Eve completely destroyed the whole avenue, despite the artificial screens of branches of evergreen shrubs that had been annually adopted for their protection from severe winterly weather, so I have been informed by a trustworthy

eye-witness, who also stated that the cones produced by the trees in question always proved seedless. The trees, curiously, were all females, and had no opportunity of impregnation. In further reference to the dicœcious character of this genus of Conifers, I am informed that the Maresfield trees, as indicated, failed to produce fructiferous cones until males were planted within suitable proximity to them. Pertaining, further, to the sexuality of the Araucaria, I believe that a distinguishing character exists in the size of the foliage, that of the cone-bearer being considerably the larger.

Bearing on the sudden fruition of the Inveraray tree, it may be interesting to relate a parallel case, which occurred upwards of twenty years ago, when I was residing in the neighbourhood of Stratford-on-Avon. A fine specimen of that beautiful Spanish silver fir (*Picea Pinsapo*), on one windy day, became prostrate, and exposed, to my surprise, the greater portion of its main roots in a fungous, diseased condition, thus solving the problem why the tree had for the last few years assumed a stunted growth. Fortunately, however, as two or three of the main roots on one side of the tree remained intact, I resolved to raise it to its former position, after having cut away every vestige of diseased or broken roots; which was successfully accomplished by the aid of a stout rope and pulley-block, and a dozen able men. Subsequently the tree did not appear to suffer materially from the trying ordeal it had been subjected to, and my anticipations of its resuscitation were shortly afterwards justified by a healthy renewed growth, and the interesting appearance, in the course of two or three years, of a crop of beautiful cones, specimens of which I exhibited at one of the Royal Horticultural meetings in 1869, and for which a "Special Certificate of Merit" was awarded. Evidently the cause of this abnormal fruition—as in the case of the Inveraray Araucaria—was owing to arrested growth. In conclusion, I may add that I failed to discover the real cause of the decay of the Picea's roots, but attributed it to something unsuitable in the almost impervious damp subsoil, the fungous condition being only consequential.

WILLIAM GARDINER.

Harborne, Birmingham, November 15.

P.S.—Respecting the sexuality of the Araucaria, it would be instructive as well as interesting could any of your correspondents define any comparative specific character possessed by the plants, such, for instance, as the foliage or general habit, when in their earlier life, and whereby they may be distinguished.—W. G.

EARLY this summer the Araucarias of large size around Terregles House, near Dumfries, were in fruit. Many of the shed cones were lying at the base of the plants. Several years ago I saw a fine Araucaria in fruit in the manse garden, Colvend, Kirkcudbrightshire; but learned from the incumbent that the sight was a rare one. About the middle and end of October, this year, we had numerous trees of the mountain ash from which the leaves had fallen, but which stood glittering, laden with red berries. Clouds of fieldfares arrived, at first noisy and shy, perching on the tops of larch-trees. They devoured these berries, and, getting bolder, invaded my garden, and clustered on a mountain ash in such numbers that there could not be less than 200 at one time. At two visits of one hour each, in one day, every berry disappeared from that tree. Now the flocks of fieldfares are no longer visible, and the berries of the hawthorn and other wild fruit do not seem to attract them, while not a berry of the mountain ash could be picked up for many miles.

JAMES SHAW.

Dumfriesshire.

THE GENESIS OF TROPICAL CYCLONES.

ACCORDING to the views of Dr. Hann, as explained in a previous number of this journal, (Nov. 6, p. 15) the storms of the temperate zone originate, not in the convective ascent of warm damp air (an explanation, however, which he appears to admit in the case of tornadoes), but in great vortical movements of the upper air-currents, which commence over the equator as the anti-trades, and set continuously towards the poles, being gradually diverted eastwards in consequence of the earth's rotation. Owing to the spherical form of the earth's surface, these currents become irregularly congested as they necessarily converge on reaching higher latitudes, and thus give rise to anticyclones, or tracts of excessive accumulation and pressure, and to cyclonic vortices in the intervals. Admitting this view as at least highly probable, the question now to be considered is how far similar conditions hold good in low latitudes. Do the cyclones of the tropical zone originate in like manner, or are they not rather primarily due to the conditions of the lower atmosphere, to the production and condensation of vapour over a calm region, and the creation of an upcast current?

In the first place, it is to be observed that in low latitudes those causes which impede the even flow of the upper currents are at a minimum. Their tendency to congestion must vary as the contraction of the degrees of longitude in successive parallels of latitude; and whereas between latitude 40° and 50°, for instance, this amounts to 16 per cent. of the length of the degree, and between 50° and 60° to 22 per cent., between 5° and 15° it is little more than 3 per cent. Accordingly, the non-periodic oscillations of the barometer, which, in Europe, frequently amount to an inch in the course of a day or two as cyclones and anticyclones successively sweep past, in the latitude of Madras (13° N.) rarely much exceed a tenth of an inch in the whole course of a month. But cyclones originate certainly as low down as latitude 8°, and instances have been recorded in 7° and even 6°.[1]

On the other hand, the supposed alternative cause, viz. the production and condensation of vapour, is at a maximum in low latitudes, and the facts recorded by Eliot, Pedler, and others who have traced out the early history of Bay of Bengal cyclones, go to show that their formation is determined by the inrush of a saturated current from the equatorial sea, and that this inrush is preceded by at least one or two days of disturbed squally weather in the birthplace of the storm. Moreover, the evident relations of these storms to the features of the terrestrial surface, always in the early stages of their existence, and frequently after they have been maturely developed, seem to admit of no other conclusion than that they are, primarily at least, phenomena of the lower atmospheric strata, even though at a later period the vortical movement may be imparted to the greatly elevated anti-trade, and so be carried forward into higher latitudes. And lastly, as Dr. Hann has himself shown, the temperature test, which he rightly appeals to as crucial, and which in his hands has led to the overthrow of the condensation theory of extra-tropical storms, does not fail when applied (as far as the data admit of) to the case of tropical cyclones. On each of these points some further elucidation is necessary.

First, as regards the place of their origin; and in these remarks I shall restrict myself to the storms of the Bay of Bengal and the adjacent Indian continent, which have been more closely studied than those of other tropical seas. A chart given by Mr. Eliot in his recently published "Hand-book of Cyclonic Storms in the Bay of Bengal" shows that they are generated with about equal frequency in all parts of the bay betweeen N. latitudes 8° and 18°. Between latitude 18° and the Bengal coast they are much more frequent, though generally of less intensity. But they are formed very rarely indeed over any part of the Indian peninsula. I can remember but one such case during an experience of many years' daily study of the weather charts. And although they originate somewhat more frequently in Lower Bengal during the height of the monsoon, even these instances are rare in comparison with those of storms generated at the head of the bay during the same season. With but few exceptions, therefore, they are formed only over the sea, and these exceptions are nearly all restricted to the low plain immediately north of the bay. If the original impulse were a vortical movement of the higher atmosphere, it

[1] See the list of storms in Appendix II. to the "Weather and Climates of India."

would be difficult to account for this practical limitation of the storm cradle to the surface of the bay; whereas on the alternative assumption the reason is obvious.

Next, with respect to season and antecedent circumstances. The fierce and destructive cyclones which accompany the changes of the monsoons are generated chiefly in the south of the bay in the spring and late autumn, and further north at the beginning of the summer and in the earlier autumn months; while during the height of the summer monsoon, the less severe storms, which I have elsewhere distinguished as "cyclonic storms," are formed in the extreme north of the bay, and occasionally, though rarely, over the plains of Bengal; in which case they never attain to any great strength. Over the storm cradle at the outset, and everywhere to the north of it, the atmosphere is calm and sultry, or moved only by light variable winds; and at the change of the monsoons, when storms are formed far out in the bay, the atmospheric pressure is nearly uniform all over the bay, and even over the land there are only those slight differences, it may be either of excess or defect, that are due to the normal distribution of the season. Cyclone formation seems to be but little if at all affected by the barometric condition of the atmosphere over the Indian continent. But storms always originate somewhere beyond the northern limit of that saturated equatorial atmosphere which is itself fed by the southern trade winds, and is the reservoir from which is drawn the rainy summer monsoon. In this direction the pressure is always somewhat higher, but until the cyclone has formed, the gradients are gentle.

Thus the average birthplace of storms advances and recedes with the northern limit of the southern monsoon, being always situated beyond it in the region of nearly uniform and relatively low pressure, calms, or light and variable winds, which extends over a greater or less area beyond that limit.

Over the cradle of a storm, the formation of a vortex is always preceded by disturbed squally weather, during which the barometer falls slightly over the disturbed area. In most instances this lasts for two or three days, sometimes longer, and during this period there is but little rain around the coasts of the bay. As this preliminary occurrence of squally weather is a point of some importance, I will quote a passage describing it more fully from Mr. Eliot's recent work:— "The history of all cyclones in the bay shows that they are invariably preceded for longer or shorter periods by unsettled squally weather, and that during this period the air over a considerable portion of the bay is gradually given a rapid rotatory motion about a definite centre. During the preliminary period of change from slightly unsettled and threatening weather to the formation of a storm more or less dangerous to shipping, one of the most important and striking points is the increase in the number and strength of the squalls which are an invariable feature in cyclonic storms from the very earliest stages. First of all the squalls are comparatively light, and are separated by longish intervals of fine weather, and light variable or steady winds, according to the time of year. They become more frequent, and come down more fiercely and strongly, with the gradual development of the storm. The area of unsettled and squally weather also extends in all directions, and usually most slowly to the north and west. If the unsettled weather advances beyond this stage (which it does not necessarily do), it is shown most clearly by the wind directions over the area of the squalls. The winds always settle down into those which invariably occur over an area of barometric depression or cyclonic circulation, or, in other words, are changed into the cyclonic winds of indraught to a central area of low barometer and heavy rain. As soon as the wind directions indicate that a definite centre of wind convergence has been formed in the bay, it is also found that the centre never remains in the same position for any considerable interval of time, but that it moves or advances in some direction between north-east and west, with velocities which not only differ very considerably in different storms, but also at different stages of the same storm."

Such being the facts, as gathered from the detailed study of a great number of storms, their most probable interpretation seems to be somewhat as follows. It may be taken as an established fact that rain is, practically in all cases, the result of the dynamic cooling of ascending air, and that whenever the rain is accompanied by squalls this ascent is irregular and spasmodic. If so, the weather that precedes a cyclonic circulation, as described in the foregoing paragraph, indicates that over a previously calm area the lower atmosphere gradually acquires a spasmodic ascending movement, at first sporadic but gradually becoming concentrated as the influx of the surrounding atmosphere impresses a spiral movement on the general mass. With the influx of the saturated current from the south, this action is greatly accelerated, and the vortical movement which has originated in the lower atmosphere is imparted to the higher atmospheric current, which carries it forwards, at first slowly, and then with increased velocity, as the movement gradually extends to the higher and more rapidly moving current of the general atmospheric circulation.[1] Were the seat of the original disturbance in the bosom of the upper current, it is difficult to see why the disturbed condition of the lower atmosphere should remain stationary during the incubation of the storm, or why it should exist sometimes for two or three days in anticipation of the spiral circulation, which, on this hypothesis, is the determining impulse of the whole phenomenon.

I am not aware that anyone has as yet made a special study of the circumstances under which the storms of the temperate zone originate. Some of them doubtless enter this zone from the tropics. But as the result of a somewhat cursory examination of the Atlantic charts published by the Meteorological Council, others appear to be formed very rapidly either as secondary eddies in the circulation of the North Atlantic atmosphere around Iceland, or in the V-shaped depressions between two neighbouring anticyclones. In neither case does there appear to be that prolonged incubation that characterizes the Bay of Bengal storms; notwithstanding that heat and vapour must be far less active agents in high than in low latitudes. Indeed, this consideration seems to add support to Prof. Hann's views, while it also tends to strengthen the probability that tropical and extra-tropical storms arise from a different class of actions.

Further evidence that tropical cyclones are originally and chiefly phenomena of the lower atmosphere is afforded by the fact that even the most violent storms are often broken up by hills of very moderate height. Notably was this the case with the destructive Backerganj cyclone of November 1, 1876, a very large and violent storm, which nevertheless broke up on reaching the low hills of Tipperah; and perhaps a majority of the cyclones that cross the Coromandel coast from the bay are dissipated by the ghats and hill-groups of the Carnatic, few of which exceed 5000 feet in height. In these cases, a disturbed state of the atmosphere indicated by heavy rain outlasts the cyclone sometimes for two or three days, but the strongly-marked vortical circulation disappears.

It has been suggested to me by Prof. Hann that even

[1] This assumes, of course, that the poleward current of the general circulation exists normally above the calms and variable currents of the monsoons, and such is equally the assumption of the opposite hypothesis. The observations on the progress of the Krakatão dust-cloud indicate only a very rapid westerly current, circulating around the globe in the equatorial zone in August. Those of the movements of high clouds at Calcutta and Allahabad, at a much less elevation than the Krakatão dust-cloud, indicate very variable directions in the summer and autumn, but chiefly southerly at Calcutta, and west or south-west almost exclusively at both stations during the remainder of the year. See the tables in the "Weather and Climates of India," pp. 60, 61.

if the severe cyclones of the transitional periods of the monsoons arise in the way I have above indicated, the milder but more lasting "cyclonic storms" of July and August which are generated in the extreme north of the bay, and which often traverse a great part or the whole of Central and North-Western India before they break up, may nevertheless be formed in the same manner as those of the temperate zone. But this seems to me extremely improbable. With the single exception of the place of their origin, the circumstances of their formation are essentially identical with those of the former class. Moreover, the track which they almost invariably follow seems to be determined by the distribution of the monsoon currents, being along the trough of low pressure which lies between the easterly and westerly branches of the monsoon of Northern India. Although the belt of broken hilly ground running across Central India is generally traversed by the storm vortex, the winds which mainly feed it from the bay have a clear sweep up the great Gangetic plain, and those from the Bombay coast, after surmounting the ghats, have a tolerably unimpeded course across the Deccan plateau, whereas in such cases as the Backerganj cyclone, the whole broad range of the Arakan Yoma, from 5000 to 7000 feet in height, presents an obstacle to the single feeding current from the Bay of Bengal.

I come lastly to the crucial test of temperature—to the question, namely, whether the mean temperature of the air-column in a tropical cyclone is such as to render it specifically lighter than the surrounding atmosphere, and therefore such as to promote an ascending movement. We have indeed in this case no high-level observations to appeal to, such as are furnished to Dr. Hann by the Alpine and other mountain observatories for the storms of the temperate zone. But Dr. Hann has made a rough computation which enables us to bring it fairly to the test, and which in the case of European storms was found to give a result entirely justified by observation. In a paper published in the September number of the *Meteorologische Zeitschrift* he has computed the temperatures of the air-column over a tropical cyclone at different elevations, on the assumption of adiabatic cooling, and has compared these with the average normal temperatures of the atmosphere at the same elevations as deduced from the observations of Newera Eliya, Dodabetta, and Antisana. As the result, he finds that the mean temperature of the former is probably about 2° C. higher than that of the latter, and therefore such as to produce an upward movement of the cyclonic atmosphere, with an acceleration equal to about $\frac{1}{300}$ of the force of gravity. It may indeed be somewhat greater than this, since in his computation Dr. Hann has assumed a temperature of 28° C. or 82°·4 F., and a relative humidity of only 80 per cent. for the atmosphere of the cyclone at sea-level. In point of fact, observation shows that in a cyclone in the south of the bay the temperature at the sea-level is 79° or 80°, but that the air is saturated, or close upon saturation. Making this correction of the data, the mean temperature of the cyclonic air-column will be about 3° C. higher than that of a normal atmosphere, equivalent to an accelerating force of $\frac{1}{200}$ of gravity.

From every point of view, then, whether we regard the place and circumstances of their origin, their behaviour after formation, their physical constitution, or the relative activity of the causes supposed to be concerned in their production, the conclusion seems irresistible that tropical cyclones originate in a manner quite different from that ascribed to the storms of the temperate zone; that they are in their early stages a disturbance of the lower atmosphere; and that the primary impulse is given by the ascent and condensation of vapour.

These remarks apply only to the "cyclones" of the beginning and end of the summer monsoon, and the "cyclonic storms" of the summer months. The storms that traverse Northern India in the winter and early spring, which always travel eastward, and but very rarely descend within the tropic, are of quite a different character, and may not improbably originate in the manner suggested by Prof. Hann.

HENRY F. BLANFORD.

THE DE MORGAN MEDAL.[1]

IN 1869 Lord Rayleigh commenced the long series of papers and memoirs in Mixed Mathematics, which the Council had in view in making the award, with an article (*Philosophical Magazine*, vol. xxxviii., third series) "On some Electro-magnetic Phenomena considered in connexion with the Dynamical Theory," founded on Clerk-Maxwell's celebrated "Dynamical Theory of the Electro-magnetic Field" (Phil. Trans., 1865), the subject being "Examples of Electro-magnetic Problems illustrated by comparison with their Mechanical Analogues." I may add, to complete the key-note, thus struck, of Lord Rayleigh's scientific career, that these theoretical results were followed up in the next year by an account of "An Electro-magnetic Experiment," viz. the magnetizing effect of an induced current as dependent on the self- and mutual inductions of the circuits—an early instance of the author's practice of making theory and experiment, or concrete example, illustrate one another. This combination of experimental with mathematical skill and fertility of resource has been conspicuous in Lord Rayleigh's later memoirs on the "Determination of the Ohm and B.A. Unit of Resistance in Absolute Measure" (Roy. Soc. Proc., vol. xxxiv., and Phil. Trans., vol. clxxiii., 1882.)

Confining myself to those earlier memoirs and papers by Lord Rayleigh in which mathematical investigation predominates, the next which calls for notice is one of considerable length, "On $\int_0^1 Q_n Q_{n'} d\mu$ ($Q_n Q_{n'}$ being Laplace's coefficients of orders n, n'), with an Application to the Theory of Radiation" (Phil. Trans., 1870); in which, instead of the two Q's being multiplied together and integration then effected, the flank of the difficulty is ably turned and the object attained with comparative ease. The mathematical results are illustrated by their application to the problem of "finding the stationary condition when a uniform sphere is exposed to radiation from infinitely distant surrounding bodies."

"A Memoir on the Theory of Resonance" (Phil. Trans., 1871), is the first of Lord Rayleigh's numerous essays in the mathematical theory of sound, which were preliminary, or have been a sequel, to his well-known Treatise, of which the two volumes appeared successively in 1877 and 1878.

The subject of the Memoir is an investigation of air-waves (of the fundamental note) in hollow spaces, whose three dimensions are small in comparison with the wave-length, and which communicate with the atmosphere by necks similarly limited. The theory is shown to be applicable to cases of multiple resonance, as when two or more such hollow spaces are connected by necks and communicate with the external air by necks.

The question of the calculation of c, a factor or co-efficient occurring in some of the differential equations, is treated in a noteworthy manner, suggested by the remark that, if the air were replaced by uniform conducting matter of unit specific conducting power, and the sides of the vessel by insulators, c would be the measure of electric conductivity between the interior of the vessel and external space, "an analogy freely availed of, . . .

[1] Address to the London Mathematical Society on the occasion of the presentation of the De Morgan Medal to Lord Rayleigh, November 13, 1890, by the President, J. J Walker, F.R.S.

much circumlocution being thereby avoided on account of the greater completeness of electrical phraseology."

Having joined our Society in 1871, Lord Rayleigh commenced that series of communications in Applied Mathematics, by which our Proceedings have almost every year since been enriched, with a paper in Physical Optics, "On Verdet's Explanation of Coronas" (vol. iii. p. 267), in which a fallacy of reasoning in his mathematical work is pointed out, but its disappearance in the result explained.[1]

This is the first of many important papers evincing the critical manner in which Lord Rayleigh studies the work of his predecessors or contemporaries, while sympathetically and appreciatingly recognizing the value of their contributions to the progress of Physical Science.

To the fourth volume of our Proceedings was contributed an important triad of papers:—

(1) "On the Vibrations of a Gas contained within a Rigid Spherical Envelope," a problem referred to in the Memoir on Resonance, in which the author indicated the only case of the vibration of air within a closed vessel which had prior to that time been completely worked out, the motion being assumed to be irrotational. The solutions of the differential equations are expressed in terms of Harmonic Functions; and, incidentally, interesting theorems in Operations are proved, if in Laplace's Coefficients μ is replaced by the first or second power of the Operative symbol $1 - d/dy$, the Operand being $1/y$.

I would suggest to those having leisure and taste for such a research the possibility of these theorems being generalized for any positive integral power of the Operator.

(2) The second paper, "On the Disturbance produced by a Spherical Obstacle on Waves of Sound," begins with a series of mathematical lemmas of great interest: the expansion of the velocity potential in a harmonic series, with special consideration of the case of its being finite at the poles, and an independent solution of the case of plane waves; a method leading to an expression in terms of Bessel's Functions of fractional order being explained and applied. A comparison of the two results gives a relation of great elegance between a Laplace's Function of order n and a Bessel's Function of order $n + \frac{1}{2}$.

In an Appendix, the expansion of the Velocity Potential for spherical waves is worked out.

Intimately connected with this second of the three papers are two which appeared in the *Philosophical Magazine* for April and June 1871: "On Light from the Sky, its Polarization and Colour," and "On the Scattering of Light by Small Particles," discussed mathematically. The latter paper, setting out with supposing both density and rigidity of the media variable, shows that there can be no direction in the plane perpendicular to the incident ray in which the scattered light vanishes. Hence, either there is no difference of rigidity (the supposition of the former paper), and the vibrations are normal to the plane of polarization; or no difference of density, and the vibrations are parallel to the plane of polarization—which latter alternative is then disproved.[2]

(3) The third of the triad of papers referred to bears the title, "Some General Theorems relating to Vibrations," with which the Author "had lately become acquainted during the preparation of a work on Acoustics." The first principle proved is that "the natural periods of a conservative system, vibrating freely about a configuration of stable equilibrium, fulfil the stationary condition."

Some applications of the principle are pointed out, and in illustration of one of these—the approximate calculation of a complicated system, but slightly different from one of a simpler nature—the problem of the transverse motion of a stretched string of slightly unequal longitudinal density is worked out. Another instructive example is that of the tones of a square plate when the type of vibration is such that the nodal lines are central and parallel to the edges, the tone being then gravest, and that in which the diagonals are the nodal lines. The former case is here discussed mathematically for the first time, and Chladni's experimental results shown to be confirmed. An important remark on the *possibility* of expansion by Fourier's Theorem, Laplace's Series, or Bessel's Functions, in a large number of cases being inferred from physical considerations, is added.

The second principle is that forces which vary as the component velocities (absolute or relative) of the vibratory motions of the parts of the system may be advantageously treated by the method of Virtual Velocities. The investigation leads to the introduction of a function, F (the "Dissipation Function"), which, like the Kinetic and Potential Energy Functions, is a positive quadratic function of the co-ordinates, and represents the rate at which Energy is dissipated. Its application in the fourth chapter of the Author's great work on Sound will at once occur to those acquainted with it. Finally, a law of reciprocity of a very general character is established, relating to the interchangeability of forces and motions of any two types.

The subject of Reciprocal Theorems in Dynamics has been recently (January 12, 1888) treated in our Proceedings by Prof. Lamb, led thereto by a reciprocal theorem, proved by von Helmholtz in a paper "On Least Action" (*Crelle*, vol. c.), which seems much the same as Lord Rayleigh's, if somewhat more generally expressed.

Arising out of this theorem is "A Statical Theorem," communicated by Lord Rayleigh to the *Philosophical Magazine* (vol. xlviii., 1874), referring to a reciprocal property of a system capable of vibrating, with or without dissipation, if displaced from a position of stable equilibrium. The application of the principle in Acoustics (introduced into the "Theory of Sound") formed the subject of a communication to the Royal Society (Proceedings, xxv., 1876).

In this enumeration of some of Lord Rayleigh's earlier papers should be included two of a pure mathematical character on Bessel's Functions, viz. (1) "Notes" thereon, published in the May number of the *Philosophical Magazine*, 1872, in which their great utility in questions of the conduction of heat or electricity, or of a hydrodynamical nature, with conditions to be satisfied by circular, spherical, and cylindrical surfaces, is pointed out. It is needless to remark how constantly these Functions have since been pressed into service in such cases.

(2) "On the Relation between the Functions of Laplace and Bessel," communicated to our Society (Proceedings, vol. ix., January 1878), in which the Function of zero order is shown to be the limit of Legendre's (P_n), and the general Function that of an "Associated" Function of Laplace, where n becomes infinite, but n sin . angle cos μ remains finite. A linear relation among three consecutive Associated Functions, which in the limit becomes the well-known one among three consecutive Bessel's Functions, established by their discoverer, follows.

In connexion with the two papers just noticed, allusion may be made to a "Note," also contributed to our Proceedings (June 11, 1874) "On the Numerical Calculation of the Roots of Fluctuating Functions," pointing out how the difficulty of evaluating them when the argument is neither very small nor great may sometimes be met; the

[1] What regretful thoughts are stirred up by the recollection that Clerk-Maxwell joined in a discussion of this paper, commenced by Sir W. Thomson! From 1871 to his death, Prof. Maxwell was a frequent participator in, as well as contributor to, our meetings. "Quis desiderio . . . !"

[2] The volumes of the *Philosophical Magazine* for the same year (1871) contain two other optical papers of great interest:—

"On Double Refraction" (vol. xli.), in which the mathematical treatment of the subject, by supposing density to be a function of the direction of vibration, leads to the replacing Fresnel's ellipsoid by its polar reciprocal. Reference is made to Stokes's Report.

"On Reflexion of Light from Transparent Matter" (vol. xlii.), the object of which is "to see how far the facts might be accounted for by the different hypotheses which have been made as to the condition of the æther in transparent matter."

method, though not limited to, having arisen out of, and being exemplified by, Bessel's Functions.

I pass now to Lord Rayleigh's work subsequent to the award of the medal in 1887, which the Council are enjoined by the rules for their guidance to take into special consideration. In the *Philosophical Magazine* for August 1887 there is a paper "On the Maintenance of Vibrations by Forces of Double Frequency," a sequel to that "On Maintained Vibrations," *ibid.*, April 1883. To this subject Lord Rayleigh tells us his attention had been recalled by Mr. Glaisher's Address to the Royal Astronomical Society in the preceding February, in which he had given an interesting account of the treatment of mathematically similar questions, occurring in the Lunar Theory, to those herein considered, by Mr. Hill, published in the *Acta Mathematica* of the preceding year. The appearance of a "dissipative term" in the equation of motion of the vibrating body prevents it being treated as a special case of Hill's similar equation in the motion of the Lunar Perigee. The results are expressed by determinants, and one of the recent papers of Dr. Muir is referred to, on the relations of the special class of determinants involved to continued fractions. Applications to the case of the vibrations of a laminated medium, in which the mechanical properties are periodic functions of one of the co-ordinates—a problem connected with the colours of thin plates; and to the problem of the stationary vibrations of a string of variable density fixed at two points, follow.

In our Proceedings for November 1887, will be found a paper "On the Stability or Instability of certain Fluid Motions," forming a sequel to a former paper on the same subject in our eleventh volume (1880), to which Lord Rayleigh's attention had been re-directed by a recent work of Sir W. Thomson's. In this the subject is treated with greater generality.

In the following year Lord Rayleigh communicated to our June meeting a short but interesting investigation, "On Point, Line, and Plane Sources of Sound," giving rise to a definite integral the connection of which with Bessel's Functions is worked out by Lipschitz's method (*Crelle*, 1859), referred to in the paper of 1877 on Bessel's Functions.

In the Royal Society Proceedings, December 13, will be found a paper in which Mr. Love's objections (Phil. Trans., 1888, A., p. 545), to the line of argument followed in Lord Rayleigh's paper in the thirteenth volume of our Proceedings (1881), "On the Infinitesimal Bending of Surfaces of Revolution," are replied to with great fulness. The interest aroused by these discussions will be well remembered by those who followed them; and allusion to them has since been frequently made at our meetings.

The same memoir by Mr. Love drew forth another mathematical investigation by Lord Rayleigh (Roy. Soc. Proc., February 26, 1889), "On the Free Vibrations of an Infinitely Long Cylindrical Shell."

At our meeting, April 11, 1889, a paper by Lord Rayleigh was read, "On the Free Vibrations of an Infinite Plate of Homogeneous Isotropic Elastic Matter," a particular case of which "On Waves Propagated along the Plane Surface of an Elastic Solid" had been investigated in a communication to our November meeting of the year 1885.

In the before-mentioned years (1888–89), Lord Rayleigh contributed four important papers in the mathematics of Physical Optics to the *Philosophical Magazine*.

(1) "On the Reflexion of Light at a Twin Plane of a Crystal" (*Phil. Mag.*, September 1888). For the calculation of reflexion at the surface between twin crystals, the electric theory of Clerk Maxwell is found to be the only one satisfying the conditions essential to success—as capable of explaining at once Fresnel's laws of double refraction and those governing the intensity of reflexion when light passes from one isotropic medium to another. Starting with Maxwell's equations connecting the components of the electric displacement and current, magnetic force, electro-magnetic momentum and force, and taking the plane of transition as $x = 0$, Fresnel's tangent formula for isotropic reflexion is obtained; then his law of velocity for propagation in a crystal.

Reflexion at a twin plane is then limited to the cases of the plane of incidence, being (1) coincident with, (2) perpendicular to, the plane of symmetry. In the former case it is shown that the ratio of the amplitudes of the reflected and incident light is equal to the difference of two expressions proved to be equal, whether the vibrations are parallel or perpendicular to the plane of incidence, and no light is reflected whether the incident light be natural or plane-polarized, or elliptically polarized.

The values of the parameters which multiply the exponents in the two reflected waves in the second case are then worked out. Finally, particular cases of these general results are discussed.

(2) "On Interference of Light radiated from Moving Molecules" (*Phil. Mag.*, vol. xxvii. 1889) combats Ebert's conclusions by showing that the maximum admissible retardation is 4·5 times greater than assumed by him (*Wied. Annalen*), whence the width of the spectral lines should be much greater than found, which would involve a blow at the dynamical theory of gases.

(3) "On Complete Radiation at a Given Temperature" (*ib.*), founded on Gouy's "Theory of Irregular Impulses," investigates what type of similar impulses would by their aggregation represent complete radiation. The probability of various amplitudes depends on principles explained in an article in the *Philosophical Magazine*, August 1880, "On the Resultant of a Large Number of Vibrations of same Pitch and Arbitrary Phase." The form of impulse (familiar in the Theory of Errors)—

$$\phi(x) = \text{exponent } (-c^2x^2),$$

which is resolved into harmonic components by Fourier's Theorem, is discussed.

(4) "On Achromatic Interference Bands" (*Phil. Mag.*, vol. xxviii., August and September 1889). A development of notice of in the article "Wave Theory" ("Enc. Brit.," 1888), founded on Cauchy's law of dispersion; with a reference to Mascart, "Achromatism of Interference" (*Comptes Rendus*, March 1889).

These abstracts, imperfect as they are, may serve to convey to those who have not closely followed his work some idea of the great variety of subjects in Mixed Mathematics discussed and advanced by Lord Rayleigh, and on which that distinguished reputation in these domains is founded, their recognition of which the Council of the London Mathematical Society desire to mark by the present award of the De Morgan Medal.

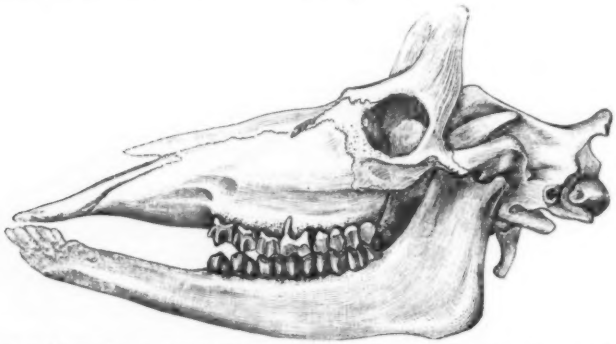
A NEW FOSSIL MAMMALIAN FAUNA.

THE trustees of the British Museum have recently added to the collection at South Kensington a large series of fossil remains of mammals purchased from Prof. C. J. Forsyth-Major, which are of especial interest from several distinct points of view. These remains were obtained within the last two or three years by Prof. Forsyth-Major from a Tertiary deposit in Samos—an island in the Turkish Archipelago, lying immediately opposite the town of Ephesus, and to the south-south-west of Smyrna. This deposit, which has been discovered only quite recently, appears to be absolutely full of the bones of mammals; and in this respect it agrees with the contemporary deposits of the celebrated Pikermi ravine near Athens, the wonderful mammalian fauna of which has been fully made known to us by the labours and writings of Prof. Albert Gaudry, of the Paris Museum, and other palæontologists.

The deposits at Samos have, however, one great advantage over those of Pikermi. Thus, in the latter locality the rock in which the bones are embedded is stained of a brownish-red colour, and very frequently adheres so closely to the bones that they cannot be properly cleaned from matrix; whereas in the case of Samos the rock is of a buffish-white, and can be completely removed from the specimens. This whitish colour of the Samos bones renders them peculiarly attractive objects in a museum; and the contrast between the white bones and the pale-brown of the enamel of the teeth in the magnificent series of skulls now displayed in the Museum is very striking. So well preserved, indeed, are these specimens that many of the skulls are almost as well suited for precise anatomical comparison as those of existing species.

The number of specimens from these deposits acquired by the Museum is no less than 533; the whole of these, with the exception of one bone of a bird, belonging to mammals. As another collection of at least equal extent has been acquired by the Museum at Geneva, the importance of this newly discovered fossil fauna may be readily estimated.

The discovery of this ossiferous deposit, taken in conjunction with that of the equivalent beds at Maragha, in Persia, which were brought to the notice of the scientific world only a few years ago, indicates that there is still hope of much further knowledge of the Tertiary mammalian fauna being eventually obtained by the full exploration of regions lying beyond the European area. As we have already mentioned, the Samos deposits are the equivalents in point of time with those of Pikermi in Attica, and of Maragha in Persia; this identification resting upon the general similarity of the fauna of the three areas, although each locality has some peculiar types not known in the others. The researches of Mr. W. T. Blanford and others have shown that we must assign a Pliocene age to the deposits at Pikermi. And with our present knowledge, the Pikermi fauna may now be traced from Baltavar in Hungary, through Greece, thence to Samos, Persia, Baluchistan, the Punjab, and so to the Siwalik Hills of Northern India, the mammalian fauna of which was the first to be brought to light through the classic labours of Falconer and Cautley. From this fauna, which forms a belt in the regions surrounding the whole of the north-eastern frontier of Africa, it is now pretty certain that the modern mammalian fauna of that continent was derived; and it is noteworthy that the fauna of Samos, and still more that of the Siwaliks, contains the greater number of forms most closely allied to those of Africa. In Pikermi and Samos no true elephants occur, but in the Siwaliks elephants more or less closely allied to the existing African and Indian species are abundantly represented.



Profile view of the skull of *Samotherium*, from the Pliocene of Samos. Much reduced. (From "Guide to British Museum.")

Among the mammals discovered at Samos, a large number are identical with those occurring at Pikermi. Thus, the well-known three-toed horse (*Hipparion*) is especially common in both localities. The rhinoceroses and mastodons likewise appear to have been, in most cases at least, specifically the same. Again, many of the antelopes found at Pikermi, some of which are allied to the African oryx and others to the koodoo, reappear at Samos. A large ruminant from Samos, as yet undescribed, but to which the provisional name *Criotherium* has been applied, appears, however, to be an antelope totally unlike any existing form. In this remarkable animal the horns are set on the extreme vertex of the skull, as in the hartebeest, the gnu, and the ox, but are extremely short, tightly twisted, and bent right in front of the forehead, in a manner totally unlike that found in any existing antelope.

Perhaps, however, the most remarkable of the new mammals discovered at Samos is the large ruminant for which the name *Samotherium* has been proposed. Of the skull of this creature we are enabled, by the courtesy of Dr. Woodward, to give a figure. It will be seen from this figure that the general proportions and contour of the skull are very similar to those of the giraffe; and the molar teeth are practically indistinguishable from those of the latter. The remarkable feature of this skull is, however, the presence of a pair of upright horn-cores, situated immediately over the eyes, and inseparably connected with the frontal bones, of which indeed, as in the antelopes, they form mere projections. This condition is very different from that obtaining in the giraffe, in which, it need hardly be said, the so-called horns are short bony processes, covered with skin in the living condition, and entirely distinct from the frontal bones. The horn-cores of the samothere are, indeed, very similar to those of certain Pikermi antelopes, and were, in all probability, sheathed in horn in the living animal, This ruminant appears, therefore, to indicate a close genetic connection between the giraffes and the antelopes; and since the giraffe itself is very closely allied to the deer, while the extinct Indian sivathere exhibits many points of affinity with the giraffe, but appears to have had deer-like antlers which were never shed, we see how little importance can really be attached to horns and antlers as indicative of want of affinity, or the reverse, between their respective owners. Indeed, there can now be but little doubt that deer, giraffes, prongbucks, and antelopes, are all descended from a common stock; the intermediate and annectant types having mostly died out, although the evidence of their former existence is now slowly but surely accumulating.

The only other mammals calling for especial notice are a species of aard-vark (*Orycteropus*) and a pangolin. The aard-varks, it need scarcely be said, are now entirely

confined to Africa and Syria, and the occurrence of an extinct species at Samos may indicate that this group of animals originally reached Africa from the north-east. The fossil pangolin is very considerably larger than any of the existing species, and has been referred to an extinct genus. Since no fossil pangolin has been found in any European deposits, the occurrence of this extinct type is of some interest.

Lastly, we must not omit to mention that the deposits at Samos have also yielded remains of an extinct ostrich, although this species is unrepresented in the collection acquired by the British Museum. The African ostrich is known to have ranged into Persia and Baluchistan within the historic period, and since the genus also occurs fossil in the above-mentioned Siwalik deposits of Northern India, the evidence of its former existence in Samos shows that it once inhabited the whole of that extensive belt of country flanking the north-eastern frontier of Africa, which seems, as we have already mentioned, to have been the original home of the modern Ethiopian fauna.

In conclusion, we venture to express the hope that means will ere long be found by which this magnificent collection of fossil remains will be described and illustrated in a manner worthy of its importance and interest.

R. L.

NOTES.

WE learn that the Weather Service of the United States hitherto under the direction of the Chief Signal Officer, is to be transferred to the Agricultural Department after July 1, 1891. A chief will be appointed at a salary of 4500 dollars a year. The present Signal Corps will be discharged from the army, and will thereafter serve as civilians.

THE first *conversazione* for the season of the Royal Microscopical Society will be held in the Society's rooms, 20 Hanover Square, on the evening of Monday, December 1.

ON Friday last, a marble bust of William Symington was unveiled in the west wing of the Museum of Science and Art, Edinburgh, by Sir William Thomson, who said that Symington was the real discoverer and the practical originator of the steamboat. It was interesting to note that Symington exhibited before the Professors of Edinburgh University a model of a carriage to be moved on the public roads by the power of steam. In 1803, Symington constructed a steamer which took in tow two laden sloops, each 70 tons burden, on the Forth and Clyde Canal. The unveiling of the bust took place amidst loud cheering. Sir R. Murdoch Smith, on behalf of the Museum authorities, accepted the custody of the bust. Amongst those present at the ceremony was Mrs. Dickie, Glasgow, a granddaughter of Symington. The bust is by D. W. Stevenson, R.S.A.

M. TCHIHATCHEF, whose death we lately recorded, left 100,000 francs to the Paris Academy of Sciences, to provide prizes for naturalists who have made noteworthy Asiatic researches.

SOMEWHAT late we learn that Dr. José Jéronimo Friana died at Paris on October 31. The cause of his death is not stated, but the fact that a daughter died in the same house within three days of her father's death points to an epidemic. Dr. Friana was a native of New Granada, born in 1828, and previous to his coming to Europe he was attached to a Survey Commission, and made a collection of more than 5000 species of plants. About the year 1860 he came to Europe with his family, and never returned to his native country. The principal object of his visit to Europe was to determine his plants and prepare a Flora of New Granada. For this purpose he resided partly in Paris and partly at Kew, and spent some years working out his collections. In conjunction with the late Prof. J. E. Planchon, he commenced publishing a "Prodromus Floræ Novæ Granatensis"; but this fell through, partly, we believe, in consequence of a lack of funds, partly in consequence of Dr. Friana's time being occupied by consular and medical duties. For many years he resided wholly in Paris, and filled the position of Consul-General of the Republic of Colombia. Always hoping to be able to resume his favourite botanical pursuit, he kept his large collections at his residence. Among his published botanical work is a monograph of the Melastomaceæ, which appeared in the Transactions of the Linnean Society, and "Nouvelles Études sur les Quinquinas," containing *facsimiles* of Mutis's original drawings. The author visited Madrid, and studied the materials collected by Mutis. Apart from his scientific attainments, Dr. Friana was much loved for his extreme amiability.

HORTICULTURE has sustained a severe and almost irreparable loss in the sudden and unexpected death of Mr. Shirley Hibberd, which we recorded last week. An enthusiastic horticulturist, an accomplished writer, and a fluent and clever speaker, Shirley Hibberd occupied a position that it will be difficult to refill. He was sixty-five years of age, and for more than half that period he has been a constant figure at, and has taken a leading part in, the principal Shows and Congresses in connection with gardening and garden-botany. For upwards of thirty years he was editor of the *Gardener's Magazine*, and he was also the author of many little treatises of considerable literary merit. At the recent Chrysanthemum Show of the National Society o[illegible]santhemum Growers, held at the Aquarium, Shirley Hibbe[illegible]s the most prominent man, both in the lecture-room and as a speaker at the banquet which took place on the Thursday preceding his death. Indeed, it is supposed that he caught a chill in the conference-room, and, bronchitis supervening, the fatal result speedily followed.

IN the Reports on the progress and condition of the Royal Gardens, Kew, from 1862 onwards, there are many useful notes respecting economic and other plants. An index to these notes has just been issued, and will be welcomed by all who have preserved copies of the Reports. The work appears as Appendix III. of the *Kew Bulletin*. In this excellent periodical, to which we have often referred, are now published all notes that may be too detailed for the Annual Report on economic products and plants, to which the attention of the staff of the Royal Gardens has been drawn in the course of ordinary correspondence, or which have been made the subject of particular study at Kew. The preface to the new index concludes with the following statement:—"The *Bulletin*, of which three volumes are already published, and the fourth is in course of publication, may be looked upon as furnishing in a detailed and timely form the special information formerly included in the Annual Reports, but which a necessary economy of space precluded being treated at the length which is possible in the pages of the *Bulletin*. It may be added that the *Bulletin* is published monthly by Her Majesty's Stationery Office, and it may be obtained from Messrs. Eyre and Spottiswoode directly, or through any bookseller."

FROM January 1, 1891, the *Globus* will be edited by Dr. Richard Andree, of Heidelberg, by whose father the journal was established nearly 30 years ago.

THE Council of the University College of North Wales has just purchased for the College library the well-known collection of books belonging to Mr. E. Watkin, of Manchester (formerly of Pwllheli). It consists of upwards of 10,000 volumes, many of which are works relating to botany, chemistry, geology, and other departments of science.

THE recent fire in University College, Toronto, postponed the equipment of the psychological laboratory which Prof. J. Mark Baldwin had in view; but in the plans for the new buildings more ample accommodations are secured. The new laboratory is to be in the restored building in a retired portion of the first floor, immediately over the rooms of the physical department. It will comprise two communicating working rooms, each 16 by 21 feet, a professor's private room, to be used also as a special psychological library under charge of a fellow or instructor, and a dark room available from the resources of the physical laboratory. The first two rooms will be separated by a hall from the latter two. This part of the building will be ready for occupation, it is hoped, in the course of the next academic year. The equipment, apparatus, &c., may be delayed in consequence of the present severe tax upon the resources of the University, but special researches will be prosecuted with the aid of adapted apparatus lent from the very complete collections of the departments of Physics and Biology.

WE learn from the American papers that the provisions of the McKinley Tariff Bill include an exemption of much importance to those engaged in teaching. It permits Universities, Colleges, &c., not only to import books for the institution free of duty, but also for any teacher connected with the institution. All works in languages other than English have been placed upon the free list.

THE efforts which have been made to open commercial communication between England and the heart of Siberia by way of the Arctic Seas have at last been successful. A correspondent of the *Times*, who signs himself, "One who knows all about it," explains the circumstances connected with this remarkable triumph of skill and energy. Two ships and a tug for river work were despatched from London at the end of July and beginning of August. Owing to north-easterly winds the Kara Sea was exceptionally full of ice, so that the ships were detained for some days among ice-floes. Nevertheless, in 39 days the ships and tug reached Karaoul, 160 miles up the Yenissei, without accident. They remained there 19 days, and took 26 days to return. They were thus only 84 days, or two months and 23 days, away from the London Docks. At Karaoul they met the river expedition, which "returned safe to Yenisseisk a few days ago, and is now landing and warehousing there the valuable cargo sent out from England." The same correspondent points out that the real *crux* of the expedition lay in the 160 miles of estuary between Golcheka, at the mouth of the Yenissei, and Karaoul, at the head of the estuary, which the Russian Government had assigned as the port of discharge. Last year the *Labrador* would not ascend to Karaoul, because Captain Wiggins thought there would not be water enough to take him there, and had no steam-launch to enable him to feel his way up. On the other hand, the river ship did not dare to descend because of the gales that then prevailed. This year it was discovered that through the entire estuary there was a channel with sufficient water for ships of any draught, and the ships proceeded up the river to their destination without hindrance. It is unfortunate that Captain Wiggins was accidentally prevented from completing the work with which his name has been so intimately associated, but it was he who showed the way, and to him, more than to anyone, belongs the honour of having provided this new outlet for British commerce. That it may become an outlet of the highest importance is the conviction of no less an authority than Baron Nordenskiöld. In a letter congratulating the promoters of the undertaking, he says:—"I am persuaded that its success will once be regarded as an event rivalling in importance the return to Portugal of the first fleet loaded with merchandise from India. Siberia surpasses the North American continent as to the extent of cultivable soil. The Siberian forests are the largest in the world. Its mineral resources are immense, its climate, excepting the *tundra* and the northernmost forest region, healthy, and as favourable for culture of cereals as any part of Europe." He goes so far as to say that the future of Siberia may be "comparable to the stupendous development which we at present see in the New World."

AT the meeting of the Royal Botanic Society on Saturday, many interesting plants, tropical fruits, &c., grown in the Society's gardens, were exhibited, and the economic value of several were explained by Prof. Bentley, who also noticed a specimen of the fly Agaric on the table from Somerset, presented by Dr. Prior, as containing a very poisonous alkaloid. In some North European countries, where it is common, it is said to be used to increase the intoxicating qualities of liquor. Its name is due to the fact that an infusion in milk is used to poison flies.

PROF. LANGLEY and his assistant, Mr. Very, have been carrying on researches relating to the so-called phosphorescent light of certain insects. They lately brought the subject before the New York Academy of Sciences, and in *Insect Life* (vol. iii., 3) some account of their results is given. The insect principally used in the experiments was the large Cuban firefly (*Pyrophorous noctilucus*). The total radiant heat from the light of one of these insects (heat representing waste) was compared with that transmitted by glass from the nearly non-luminous Bunsen flame, the luminosity from which was very much fainter than that from the insect. The most accurate observations prove that the insect light is accompanied by approximately one four-hundreth part of the heat which is ordinarily associated with the radiation of flames of the luminous quality of those experimented with. Thus Nature produces this cheapest light at about one four-hundredth part of the cost of the energy which is expended in the candle flame, and at but an insignificant fraction of the cost of the electric light, which is the most economic light which has yet been devised. "Finally," the author concludes, "there seems to be no reason why we are forbidden to hope that we may yet discover a method (since such a one certainly exists and is in use on a small scale) of obtaining an enormously greater result than we now do from our present ordinary means for producing light."

THE Division of Ornithology and Mammalogy of the Department of Agriculture of the United States has recently published a Report by Dr. C. Hart Merriam on the fauna and flora of the San Francisco mountain-region of Arizona, in which views are enunciated with regard to the areas of animal and vegetable life on the North American continent different from those usually held. He maintains that there are but two primary life-areas in North America—a northern (boreal) and a southern (subtropical) area, both extending completely across the continent, and sending off long interpenetrating areas; and that the theory commonly accepted by naturalists, viz. that of three life-areas, the Eastern, Central, and Western Provinces, must be abandoned. He further recognizes seven minor life-zones in the San Francisco mountain region, four of boreal, and three of subtropical or mixed origin, the four boreal zones being correlated with corresponding zones in the north and east.

PROF. ALFRED KIRCHOFF, of Halle, contributes to the *Saale Zeitung* an article on "the anxiety with which even scientific men of repute looked forward to the autumn meeting of the International Conference on Degree Measurement, which was lately held at Freiburg." According to an abstract given by the *Times*, Prof. Kirchoff says it had been reported that a series of simultaneous observations, carried on at Berlin, Strasburg, and Prague, went to show that a decrease in latitude was in process, at least in Middle Europe, and further reports from other Observatories showed that a similar phenomenon

had been noted in other places in Europe. This implied an alteration in the direction of the earth's axis. That is, the poles and equator, latitude and longitude, are not, as usually assumed, practically fixed data, but are liable to the general terrestrial law of flux. The amount of ascertained decrease of latitude at the end of the six months' period from August 1889 to February 1890 was half a second. But it was notified to the Conference that the Berlin observations for the half-year ending last August showed an increase of latitude amounting to 0·4, or two-fifths of a second. In other words, the fluctuation of the axis is due to a minute oscillation, probably owing to some changes in the internal mass of our planet, and not to be confounded with the precession of the equinoxes.

WE are glad to note that in his address at the opening of the present term at the Johns Hopkins University, Dr. Gilman, the President, was able to speak of the prosperous material condition of the institution after its recent difficulties. Many friends came forward to support the University in its time of trial; and the trustees have been able to make a most advantageous change in a considerable part of the endowment, so that a million of dollars, lately unproductive, now stand invested in an excellent security yielding a fixed and satisfactory income. Dr. Gilman devoted a part of his address to an account of the impressions produced upon him during his recent travels in Europe.

THE new number of the *Internationales Archiv für Ethnographie* (Band iii., Heft 5) opens with a valuable and interesting paper (in German) on Venezuelan clay vessels and figures both of ancient and of modern times, by Dr. A. Ernst, Curator of the National Museum at Caracas. Among the remaining articles is one in English, by Prof. Giglioli, on a remarkable and very beautiful ceremonial stone adze from Kapsu, New Ireland. The illustrations are up to the usual high level maintained by this admirable periodical.

MESSRS. G. PHILIP AND SON have issued a second edition of "The Unknown Horn of Africa," by the late F. L. James. This edition is preceded by an obituary notice of the author, who was killed by a wounded elephant on April 21, 1890, at San Benito, about 100 miles north of the Gaboon River on the west coast of Africa, and within a mile and a half from the shore.

THE Sanitary Institute has published a volume of Transactions, which, as vol. x., continues the series issued by the Sanitary Institute of Great Britain. It contains a full report of the Congress held at Worcester in 1888. Among the contents are papers on the sanitary aspects of the pottery manufacture, by Dr. J. T. Arlidge; on the public health in India, with special reference to the European army, by Sir H. S. Cunningham; sewage disposal, by Prof. H. Robinson; the technical education of plumbers, by Mr. H. D. Matthias; some recent results obtained in the practical treatment of sewage, by Dr. Percy F. Frankland; and the smoke nuisance, under the Alkali Acts, by Mr. H. Fletcher. We may also note a lecture to the Congress, by Sir Douglas Galton; and addresses to the working classes, by Prof. W. H. Corfield, Mr. Henry Law, and Dr. J. F. J. Sykes.

AMONG the contents of the "Papers and Proceedings of the Royal Society of Tasmania for 1889," just received, is an excellent note by Colonel W. V. Legge, R.A,, on the Australian curlew and its closely allied congeners. Dealing with the migrations of the Australian curlew, he says it migrates north through the Malay Archipelago, being there met with on passage in Borneo, New Guinea, the Philippines, and other islands; thence northward along the coast of China to Amoor Land, and up to Lake Baikal, in which region it is supposed to breed. In Japan, it has been met with as far north as Hakodadi. New Zealand seems to be its eastern limit.

DR. P. KUBORN, of the University of Liége, has prepared a French adaptation of Prof. D. J. Cunningham's "Manual of Practical Anatomy." The work is called "Guide de Dissection, et Résumé d'Anatomie Topographique." It is published by Marcel Nierstrasz, Liége; and G. Carré, Paris.

MR. WILLIAM HEINEMANN has published the "authorized translation" of Dr. Koch's paper on the cure of consumption—the paper contributed to the *Deutsche Medizinische Wochenschrift*.

A DISCOVERY, which may lead to important results, has been made by M. Chabrié during the course of his experiments upon the properties of the recently isolated gaseous fluorine substitution products of marsh gas. The intimate relation between these bodies and chloroform, and the possibility of their possessing even greater physiological activity, led M. Chabrié to investigate the action of one of them, methylene fluoride, CH_2F_2, upon specific microbes, with the result that in the case of the particular bacillus experimented upon, the gas is found to absolutely destroy them. The bacteria in question, which have formed the subject of these first experiments, were those discovered by M. Bouchard, in 1879, in urine. Two eprouvettes of equal size were taken and filled with mercury over a mercury trough. Equal small quantities of urine containing colonies of the bacteria were introduced into each, and afterwards a mixture of air and methylene fluoride admitted into one of the eprouvettes, and an equal volume of air alone into the other. The two vessels were both maintained at the temperature of the body, 35°, for 24 hours. At the end of this time a few drops of the urine from each of the vessels were introduced into separate flasks containings terilized culture medium, and both maintained at the same stove temperature for 24 hours, and again for 48 hours. At the expiration of this period the urine which has stood in contact with air alone was found to have given rise to a flourishing colony of the bacteria, while that which had been in contact with the mixture of air and methylene fluoride had not given rise to a trace of a culture. According to MM Albarran and Hallé, twelve hours are ample for the development of this bacillus, hence methylene fluoride had evidently been fatal to the germs. The experiment was again repeated without the use of mercury, in sealed tubes, but with the same result. It appears, therefore, that methylene fluoride possesses the property of destroying the urinary bacteria in question. M. Chabrié has made special experiments in order to determine whether the gas possesses any local irritant action, and the results as far as they go appear to be eminently satisfactory. He is now directing his experiments upon the microbe of the hour, that of tuberculosis, and his results will doubtless be watched with considerable interest. Methylene fluoride is easily prepared by heating silver fluoride with methylene chloride in a sealed tube. M. Chabrié has also succeeded in preparing the higher homologue, $C_2H_4F_2$, ethylene fluoride, by the analogous reaction with ethylene chloride, and is extending his observations to the antiseptic properties of this latter gas. An account of the above experiments is given in the current number of the *Comptes rendus*.

OUR ASTRONOMICAL COLUMN.

A NEW COMET (?).—The following is an account that was received through Reuter, and printed in the *Times* on Monday last, relating to a comet that was visible at Grahamstown. If the statement is correct, we have represented here something that is quite unique in cometary phenomena. It has still to be explained how it was that a phenomenon of such a nature

as this was not telegraphed home at the time, and why no confirmation has been received from other sources.

"*Cape Town, November* 5 (*viâ Plymouth*).

"Mr. Eddie, F.R.A.S., reports from Grahamstown that a comet was seen at 7.45 p.m. on the 27th ult., and observed until 8.32 p.m., when the last trace faded in the south-eastern heavens. It travelled from nearly due west around the western and southern horizon at an altitude from about 20° to 25°, and disappeared in the south-east, performing during that very brief interval a journey stretching over at least 100°. It was at its longest fully 90° in length, while in width it did not exceed half a degree, except where it became very faint and slightly spread out at its posterior extremity, and where there were also faint indications of lateral division. The preceding portion was a point in cometary form, but no nucleus could be discerned.

"When first seen, it was inclined at an angle of about 45° towards the south, and was about 30° in length, but as it moved southward it became almost parallel to the horizon, with an altitude of about 20°, till it stretched along the southern horizon an enormously long, narrow, almost parallel, weird-looking riband of gray light moving visibly across the sky. It passed over several bright stars, notably α Centauri and β Argo Navis, but did not appear to dim their lustre. The moon was at the full."

THE STARS 121 AND 483 BIRM.—Mr. Backhouse informs us that these irregular variable stars now appear to be near their maxima. He says:—"They are two of the most splendid red stars that are visible in a moderate-sized telescope; 483 is the deepest-coloured star that I am acquainted with of anything like its brightness, with the exception of R Leporis; 121 is usually nearly as deep, but at present seems not so red as usual." Dunér has described the spectrum of each as Group VI. (Class III. *b*), but, as pointed out by Mr. Backhouse, it is possible that there may be variations with the maximum of luminosity, especially as one of them appears to have changed colour. The positions of the stars are 5h. 39m. 6s., + 20° 39′, and 18h. 58m. 32s., − 5° 51′ respectively.

APEX OF THE SUN'S WAY.—In *Astronomische Nachrichten*, Nos. 2999, 3000, Oscar Stampe gives an extended investigation into the position of the apex of the sun's way. The following are the numbers and groups of stars considered, and the values obtained:—

	Number of Stars.	Yearly Proper Motion.	Co-ordinates of Apex. R.A.	Decl.
Group 1	551	0″·16 to 0″·32	287°·4	+42°·0
,, 2	340	0″·32 to 0″·64	279°·7	+40°·5
,, 3	105	0″·64 to 1″·28	287°·9	+32°·1
,, 4	58	1″·28 and over	285°·2	+30°·4
		Mean	285°·0	+36°·2

This agrees well with the values found by Boss (*Astronomical Journal*, 213), viz.:—R.A. 280°, Decl. +40°, and does not differ considerably from Struve's values, viz.:—R.A. 273°·3, and Decl. +27°·3, or +37°·7, if Boss's correction be applied. The position of the apex may therefore be taken as somewhere near Vega.

ORBITS OF 61 CYGNI, CASTOR, AND 70 OPHIUCHI.—In the November number of the *Sidereal Messenger*, Mr. N. M. Mann discusses the orbits of these three interesting binaries. The period of 61 Cygni is shown to be 462 years. If this be so, then, taking the parallax of the binary as 0″·55, the mass of the system is 1·45 times that of the sun. In a previous note (*Sidereal Messenger*, vol. ii. p. 22) the author found a period of 1159 years, whilst the combined mass of the connected bodies was concluded to be only one-seventh the sun's mass. New orbits have been calculated for Castor and 70 Ophiuchi. The latter star has made an entire revolution since the first good observation, hence it is probable that the elements computed are correct, and that the places given may be relied upon for many years.

TWO NEW COMETS (*e* AND *f* 1890).—Dr. Copeland announces, in *Edinburgh Circulars* Nos. 10 and 11, the discovery of a rather bright comet, by Prof. Zona, at Palermo, on November 15, at 10h. 24·1m. local time. Its position then was R.A. 5h. 35m. 54·8s., Decl. N. 33° 23′; daily motion *minus* 5m. 32s., and *plus* 17′. This comet was observed at Kiel on the following day at 9h. 1·1m. in R.A. 5h. 30m. 46·3s., and Decl. N. 33° 37′ 6″.

Dr. Spitaler discovered a faint comet, not identical with the above, at Vienna, on the 16th inst., its place at 16h. 32m. local time then being R.A. 5h. 27m. 16·93s., Decl. N. 33° 37′ 16″. It was in the constellation Auriga, and moving slowly towards the north-east, like Zona's comet.

THE STAR D.M. + 53° 2684.—The Rev. T. E. Espin announces (*Wolsingham Circular* No. 28) that this star, 710*a* in the Espin-Birmingham Catalogue, R.A. 21h. 37m. 6s., Decl. + 53° 49′ (1890), was observed in the spring as 7·5-8·0 magnitude, but on November 15 was only of the ninth magnitude. The star is very red, with a magnificent spectrum of the third type (Group II.).

MATABELELAND.

AT the meeting of the Royal Geographical Society on Monday evening, Lieutenant E. A. Maund read a paper on Matabele and Mashona Lands. Mr. Maund was with Sir Charles Warren in South Africa in 1885, when he traversed and reported on Matabeleland. Since then he has spent much time in the country, accompanying Lobengula's two envoys to England about two years ago. He has thus had exceptional opportunities of observing both country and people, and moreover has had access to the official reports of Colonel Pennefather, the leader of the Pioneer Expedition into Mashonaland. After some introductory remarks, Mr. Maund proceeded to give a description of the country:—

"The physical features noticeable in Bechuanaland extend to the high veldt plateau of the Matopo Range, formed by vast sand-belts running east and west, varying in breadth from a few thousand yards to 50 miles, and in elevation, the crest above the trough, from a few feet to several hundred. These belts carry good grass and bush with camel-thorn trees, the bush being invariably thickest on the crest, but necessarily lacking a surface water-supply. This marked feature extends, with a few accidental variations caused by the outcropping of granite, limestone, and basaltic hills, probably from Namaqualand and Damaraland on the west to the Basuto Transvaal and Mashona Mountains on the east, and beyond the Zambezi northwards.

"The cause of these mysterious sand-belts suggests a problem in physical geography which must be left to geology to decide. They must have been raised in their present wave-like formation either by the aid of water or by a constant and powerful wind. The theory that this part of Africa was an elevated basin, which has gradually drained Zambeziward, is the most acceptable, as in the greatest depression about Lake Ngami and along the fertile valley of the Chobe there is still abundance of water. The continual washing backward and forward of the water has disintegrated the old red sandstone upper crust, and left the red sand in this formation like, on a small scale, the sand-ridges left on our sea-shore by the receding tide; while the kopjes of granite, which all have one form, stand out like rocks at low water.

"These kopjes are rocky hills, with the summits apparently denuded, leaving a flat table-top with short cliff-like edge, the *débris* having fallen in slopes at an angle of 45°, as though crumbled off as the tide fell. Beneath the sand formation is generally to be found a limestone sedimentary crust, which in the Kalahari undoubtedly preserves the water underneath from evaporation. Thus at a fountain near Vryburg, between Motito and Takoon, 20 feet beneath the surface there is a running stream 57 feet deep, doing no good to the soil, simply because it wants man, aided by science, to prevent its thus running to waste. The sandstone conglomerates at Kanje and Molopolali, and the banket formation in Matabeleland, were possibly formed by infiltration during this water age. The results of its energetic action is seen in the Matopo range, where you find hills formed of a single block of granite, looking in the distance like our Downs, but on closer inspection this gentle slope is rounded off and polished by the action of the sand-laden water. Detrition has made it as smooth as the shingle-pebbles on our shores. These hills are a favourite haunt of baboons, as immediately they are disturbed they scamper over the steepest and roundest hills, where you cannot follow them. There is apparently no glacial action, but *moulins* I have frequently found of all sizes in the smooth surface, often with the rounded boulder *in situ*. Indeed, for a long time, until I found them large and the boulder

there, I had taken them for old Mashona mills, either for crushing corn or quartz, and subsequently I found these people do utilize the smaller for the former purpose. Geologists now by a closer examination will doubtless come across fossils in the limestone crust and sand, which will decide the question as to there having been a large lake since dried up, or one gradually run off, owing to a breach having been made through the outer rim by some convulsion where the Zambezi now flows out. This lake theory was a favourite speculation of Livingstone.

"With regard to the vegetation being thickest on the crest of the belts, I can only suggest that whatever moisture falls quickly finds its way to the valleys; consequently the grass grows more luxuriantly there. The grass in these valleys, after good rains, is often 4 to 6 feet high, and, as the natives yearly burn the grass when it is driest, it naturally follows that the fire is fiercest in the bottoms than over the crest, where grass is sparse from lack of moisture. Bush and trees perish in the dells, but live through the ordeal above, and often ultimately become so thick as to be impenetrable. It is on the high veldt among the Mashona hills that the rich reefs lie, once so well worth working in prehistoric times, as is evidenced by the old workings to be found all over the country; while the rich watered valleys, from whose streams the natives now wash their quills-full of gold, are capable of raising crops and feeding cattle for the support of a large European population.

"Before going into details I would draw your attention to the map of Matabeleland and Mashonaland. It practically lies between the parallels of 16° and 22° S. lat. and the meridian of 27° to 23° E. long., and is certainly the most promising country for colonization in South Africa. Compared with the country south of it, Matabeleland is like Canaan after the wilderness; lying high, generally healthy, and very rich in minerals—gold, copper, and iron having been extensively worked by the ancients with their rude appliances. Its numerous rivers are either running, or have plenty of water in them. The soil is rich and admirably adapted for corn; cattle thrive, and there is an abundance of grass and wood. White children can be reared in the country, which is a *sine quâ non* if it is to be successfully colonized by white men; and, above all, it is sparsely populated.

"The country dominated by the Matabele is nearly as large as Germany, while the territory actually occupied by them is very small, and would compare about as Bavaria does to the German Empire. Their kraals occupy the plateau forming the watershed between the Zambezi and the Crocodile Rivers. They are a Zulu military organization, occupying a rich country which they have depopulated, and live under a despotism of the worst kind. The population may be estimated at about 150,000, and it has become a mixed people of Zulus, Bechuanas, Mashonas, and Makalakas from the incorporation of conquered elements. Their fighting strength is probably not over 14,000 to 15,000 men."

After referring to the history of the Matabele, and to King Lobengula, and giving some account of the visit of the envoys to England, Mr. Maund went on to speak of the country which has just been opened up by the Pioneer Force.

"The country about to be opened up for colonization is," he stated, "an extensive plateau, on the water-parting between the Zambezi and the Crocodile Rivers. There are no mountain peaks. To the east the slope of the land is abrupt and the country broken, many of the hills isolated and very conspicuous, while to the north-west it falls in gentle undulations. The plateau is furrowed by many considerable rivers, and their numerous tributaries. The climate in these highlands, which vary from 3000 to 5000 feet above sea-level, is far more healthy than the now well-colonized sea-board of South Africa. The seasons are well marked, and the rainfall good. For eight months, from April to November, the air is particularly dry and salubrious, and compares well with the Free State. During and just after the rains one must be careful, as in all tropical climates. But, with proper precautions, dwellings placed high, and above exhalations from the marshes left by the subsiding rivers, and above all a judicious abstinence from alcoholic drinks, the new mining and farming communities will be as healthy as are the missionaries who have lived so long there with their families.

"Here let me pay a tribute to these silent workers, whose genial hospitality and kindly attention in case of sickness is bestowed on travellers throughout Africa. In Matabeleland as elsewhere they have been the pioneers of civilization. A heart-breaking up-hill work has theirs been for the past five-and-twenty years among the truculent Matabele, and though their converts are few, their example is beneficial to whites and blacks alike. They have built comfortable brick houses, laid on water from brooks and springs, and irrigated gardens which show the capabilities of the soil. The King, it is true, is the only one at present who dares copy them: he has a large commodious brick house put up by their builder; he has too an irrigated garden after their pattern. Now, let us hope, their harvest will come, for with the advent of a white population the old order of things will quickly change in Matabeleland. The example of their health will also be an incentive to our countrymen to house themselves as quickly as possible, or we shall have direful stories of fever, simply resulting from a lack of those comforts to which they have been used, and which up here will be a necessity.

"During the last rainy season, in the months of November, December, January, and February, the rainfall in the neighbourhood of Baluwayo amounted to upwards of forty inches. Like all tropical rains they are not continuous, but come in terrifically heavy thunderstorms with hot sunshine between. At this time the King is very busy with his witch doctors, rain-making; often painted with medicine charms in bands like a tiger, or making a dreadful concoction, called by the traders 'hell broth,' to please his credulous people, who come to beg rain for their gardens.

"The months of September and October, before the rains, are the hottest in the year. All vegetation appears dried up, and the grass lands are burned off by the natives. Cattle grow thin, and are sent off low down the rivers to find grass and water. The natives have, of course, no knowledge of how to store their generous rainfall. In September I have registered a maximum in the shade ranging between 105° and 111° F., but the atmosphere is so dry that it is more easily supported than 85° near the sea-coast, where the air is saturated with moisture. The evenings and mornings are delightful, and on this high ground the heat is never enervating. During the winter months, May, June, and July, it is very cold at night in these highlands. Even on the Macloutsie River, at an elevation of 2500 feet, I have registered 15° of frost at night, with the thermometer ranging up to 80° in the day (observed with instruments registered at Kew). Mealies—that is, Indian corn—put in soak for the horses over night, have been frozen hard in the morning.

"Notwithstanding this great variation in temperature, the dry season is particularly healthy. What, however, braces the white man withers up the unclothed native. Trek oxen suffer too from this cold, and the dryness of the grass. By these remarks I wish to convey the fact that with ordinary care this country is admirably adapted to colonization by us Anglo-Saxons. Englishmen have lived up there for the last twenty years, and, what is more essential, traders and missionaries have reared large families. There is not the necessity for sending them home as with Indian children. Neither need men, as on the west coast, return home periodically, in order to recruit. Here they may make a permanent home."

After speaking of the immense agricultural capabilities of the country and of its mineral riches, Mr. Maund gave some account of the particular district through which the Pioneer Force passed:—

"Passing out of Khama's country, the B. S. A. Company's expedition found a fair agricultural country, rising only 500 feet in the 150 miles between the Tuli and Lundi. The former river is 400 yards wide at the drift. Half a dozen new rivers, whose euphonious names I need not trouble you with, are reported as running south-east to the Crocodile. At first the road led through a bush and mopani veldt, while the latter 90 miles consists of grazing flats interspersed with granite and sandstone kopjes. It is sparsely populated by Makalakas and Banyai, who are tributary to Lobengula.

"After the Lundi, the elevation gets sharper and the country more difficult; there is a rise of 1500 feet in less than 65 miles to the top of the Providential Pass, the only apparent pass (and that 8 miles long) leading from the low to the high veldt. At the Inkwe (? Tokwe) the height above sea-level is 2700 feet. This is a rapid river with water 50 yards wide and 3 feet deep, even in the dry season. The formation here changes from granite to slate, and the gold indications are very good. We are now among the ancient workings of Benmatapa, Monomotapa, or Quiteve. Twelve miles east in the mountains are the grand ruins of its ancient capital, Zimbabye, or Zimboe.

The many and vast remains of ancient buildings all point, from their propinquity to old workings, to an extensive gold industry, when the means of extraction were crude as compared with modern appliances. The country gradually rises into an undulating plateau ranging from 4530 to 5000 feet above sea-level, with park-like scenery, the eastern edge breaking away into rocky gorges, supplying many tributaries to the Sabi. The water-shed between this river and the Zambezi's tributaries is often very narrow; 100 yards would sometimes only separate the streams running to the two basins. There are apparently no inhabitants on this plateau south of the Hanyani, so cruelly have Matabele assegais done their work.

"The bush is thick and the land boggy at the head waters of these rivers, but beyond the Umfuli there are plains from which Mount Hampden rises, stretching away to the head waters of the Mazoe. The neighbourhood of Fort Salisbury is well wooded, and the petty tribal chiefs welcomed the English force, as promising them security. Prospectors are reporting favourably from all directions, and find old workings wherever they go."

Mr. Maund concluded by referring to the famous Zimbabye ruins, which he seems inclined to think are Phœnician, or at least early Arabian. But Mr. Theodore Bent, who spoke after the reading of the paper, was strongly of opinion that they are of Persian origin.

THE CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES OF THE BRITISH ASSOCIATION.[1]

AT the first Conference, held on September 4, the chair was taken by Mr. G. J. Symons, F.R.S. The Report of the Corresponding Societies Committee was taken as read. Subjects of interest to the Corresponding Societies were then discussed in the order of the Sections of the Association.

SECTION A.

Temperature Variation in Lakes, Rivers, and Estuaries.—The Chairman stated that many thermometers had been distributed, and much information had been collected during the year.

Mr. W. Watts stated that he had been conducting temperature observations in two large reservoirs belonging to the Oldham Corporation, the results of which were included in the Report of the Committee.

Mr. Cushing presented a report of weekly temperature observations taken in the River Wandle, in Surrey. The temperatures were taken between 3 and 3.30 p.m. on Sunday afternoons, and extended from October 1888 to February 1889. The observations were taken at ten different stations. The records were accompanied by a statement of the mean weekly shade-temperature, and the rainfall for the previous week. The observer, Mr. F. C. Bayard, was willing to continue the work.

The Chairman stated that he had recently been reducing experiments on evaporation which had been made for several years at Strathfield Turgiss, in Hampshire, in which the ordinary small evaporators had been compared with a tank 6 feet square and 2 feet deep. Evaporation from the tank averaged 15 inches per annum, while the smaller evaporators (owing to the high temperature of the water) indicated considerably in excess of the truth.

Meteorological Photography.—Mr. Hopkinson alluded to the success which had been achieved by the Committee on Geological Photography, and pointed out the growing importance of photography in other branches of scientific research. He then suggested the appointment of a Committee on Meteorological Photography. Photography, he said, could most advantageously be applied to the investigation of meteorological phenomena, such as the forms of clouds, lightning-flashes, and the effects of storms. The Committee would collect the photographs and keep a register of them. The study of the forms of clouds would be more satisfactory if undertaken by a comparison of photographs than of drawings; methods of overcoming the difficulty of photographing light clouds in a blue sky might be investigated; and the various phenomena connected with lightning-flashes would be a most interesting field for research. Photographs showing the effects of storms should be secured as soon as possible. If a Committee were formed, Mr. Symons and Prof. Meldola would consent to serve on it, and Mr. A. W. Clayden would be willing to act as Secretary.

[1] Abridged from the official Report which has recently been issued to the Corresponding Societies.

After some discussion, it was decided that application should be made through the Committee of Section A for the formation of a Committee on Meteorological Photography, and that the application should be supported by a recommendation from the Conference of Delegates.

SECTION C.

Sea-coast Erosion.—Mr. Topley asked assistance for the Committee investigating this matter.

Erratic Blocks.—The Rev. E. P. Knubley stated that the Yorkshire Naturalists' Union had been recording erratic blocks satisfactorily; twenty-five reports had been presented.

Geological Photography.—Mr. O. W. Jeffs stated that, through the action of the Conference of Delegates at the previous meeting of the Association, a Committee had been appointed for collecting and reporting on geological photographs. Much assistance had been rendered to this Committee by delegates from the Corresponding Societies, many of whom had sent photographs, or lists of those that had been taken. The photographs had been arranged in order to select those which illustrated well-defined strata or sections. The Report showed that many of the counties of England and Wales were as yet unrepresented, and he asked those delegates who had not yet done so to bring the matter before their Societies, and to interest photographers in the work. The object of the Committee was to secure a series of photographs illustrating the features which geologists thought best worth recording in their respective localities. The counties from which photographs had been received were: Dorsetshire, Cornwall, Devonshire, Isle of Man, Kent, Lancashire, Montgomeryshire, Nottinghamshire, Suffolk, Shropshire, and Yorkshire; there were also a few from North Wales, Scotland, and Ireland. The Yorkshire Naturalists' Union had contributed over 100. A large number of the photographs were exhibited in the room of Section C.

Prof. Bonney testified to the zeal and energy of Mr. Jeffs as Secretary to the Committee, and suggested that, when a large collection of photographs had accumulated, some of the more typical examples of geological phenomena might be enlarged for publication.

Mr. Jeffs suggested that the Committee might make arrangements with some photographer for preparing lantern-slides from the photographs for the purpose of illustrating lectures.

Mr. Wm. Gray thought that it would be an advantage if each delegate were appointed the local representative of the Committee in his own district, and authorized to collect the photographs; he would be willing to act in this capacity for the north of Ireland.

Prof. Meldola pointed out that, in taking photographs of geological sections, in which differences in the strata were often indicated only by small differences in colour, it would be an advantage to use orthochromatic plates.

The desirability was then discussed of adopting some means by which members of the British Association, and those who assisted in the work, might be enabled to procure copies of the photographs, either as lantern-slides, prints, or enlargements, and various suggestions to this end were made.

SECTION D.

Disappearance of Native Plants.—Prof. Hillhouse stated that the third Report of the Committee on this subject had been confined to the north of England, the Isle of Man, and to a few records from South Wales. The bulk of the material had been obtained directly by correspondence with the local Natural History Societies, especially the Yorkshire Naturalists' Union. Next year's Report would probably deal with the whole of Wales, and possibly adjoining counties and the south-west of England. He then gave a *résumé* of the Report, stating that it contained an account of the more or less complete disappearance from certain localities of about seventy species. In some cases the disappearance was due to natural causes, but in most to the action of man.

Mr. Hopkinson stated that nearly the whole of the ferns in his district (St. Albans) had disappeared within the last twenty years. He attributed this to London collectors and dealers, and added that there was danger of even the primrose being exterminated from the neighbourhood of London, as the roots were taken there by cartloads every year.

Mr. M. B. Slater suggested that the best plan to obtain rare plants for cultivation would be to procure a little ripe seed and

to try to raise it. He had by this means under cultivation some of our rarest British plants.

Investigation of the Invertebrate Fauna and Cryptogamic Flora of the Fresh Waters in the British Isles.—The Rev. E. P. Knubley stated that a Report of the Committee for this purpose had been presented, and that the Yorkshire Naturalists' Union had been steadily working at the subject during the past year.

SECTION G.

Flameless Explosives.—Prof. Lebour stated that the North of England Institute of Mining Engineers had continued experimenting on this subject; the South Wales Society had already helped; and one or two smaller societies had promised assistance. The result of the joint work of the Committee which had been appointed would soon be published.

SECTION H.

Catalogue of Prehistoric Remains.—Mr. Kenward said that the Birmingham Philosophical Society was recording the few ancient remains in its district. He had worked himself, and had induced others to promote the suggestions made at the Conferences at Bath and Newcastle, as well as to assist in carrying out the archæological survey proposed by the Society of Antiquaries.

Mr. Gray stated that the Belfast Naturalists' Field Club had taken the matter up, and would continue to co-operate with the Committee of the Association.

The Chairman remarked upon the advantage of being able to have at hand for reference the publications of the local societies collected by the Corresponding Societies' Committee for the purpose of preparing the catalogue of papers which formed part of their annual Report, and also called attention to the fact that a few of the older and well-known local societies had not yet become enrolled as Corresponding Societies.

The Second Conference took place on September 9, Mr. G. J. Symons, F.R.S., in the chair.

SECTION A.

Temperature Variation in Lakes, Rivers, and Estuaries.—Prof. Meldola read a communication from Dr. H. R. Mill, the Secretary of the Committee, on this subject, thanking the local societies for their assistance, and stating that the work of observers who are members of such societies is, as a rule, more regular and more accurate than that of isolated volunteers. It was desirable, he said, that the societies already assisting should continue to make observations for another year with as much regularity as possible. Additional observers were not required, as sufficient data for the purposes of the Committee were in course of being secured.

Meteorological Photography.—Mr. Hopkinson reported that the formation of the proposed Committee on this subject had been sanctioned by the Committee of Section A, and that the form of application had been forwarded to the Committee of Recommendations.[1]

SECTION C.

Prof. Lebour, representing the Committee of this Section, brought under the notice of the delegates the following Committees recommended for appointment or reappointment:—

(1) *Erratic Blocks.*—The co-operation of the Corresponding Societies which had not yet taken part in the observations was invited.

(2) *The "Geological Record,"* the continuation of which had been recommended, with a grant.

(3) *Underground Waters*, of the work of which Committee the Secretary, Mr. De Rance, would speak.

(4) *Exploration of Oldbury Hill.*—A Committee had been recommended for excavating this ancient earthwork, which was near Ightham, in Kent.

(5) *Geological Photography.*—This Committee, of which Mr. Jeffs was Secretary, had been recommended for reappointment.

(6) *Northamptonshire Lias.*—A Committee for collecting and registering the fossils of this formation had been recommended for appointment, and excavations had already been commenced.

[1] The Committee, consisting of Mr. Symons (Chairman), Prof. Meldola, Mr. Hopkinson, and Mr. Clayden (Secretary), was duly appointed, with a grant of £5.

(7) *Sea-coast Erosion.*—This Committee had been recommended for reappointment.

(8) *Registration of Type-Specimens.*—A recommendation had been sent in for the appointment of a Committee for reporting on type-specimens in museums, an important subject, in which great assistance might be rendered by local societies.

(9) *Earth Tremors.*—This Committee had been recommended for reappointment, with Mr. Davison as Secretary.

(10) *Exploration of Elbolton Cave.*—A Committee had been recommended for the exploration of this cave, which was near Skipton, and in which relics of human occupation had already been found.

(11) *Source of the River Aire.*—The object of the Committee, recommended for appointment for the purpose of investigating this question, was to ascertain, if possible, by means of the coal-tar colouring-matter, fluorescein, whether the water which flows out of Malham Tarn and disappears down a "water-sink" to the south of the tarn, is the stream which emerges at Malham Cove or Aire Head, or at both these places. The use of the dye for this purpose had been suggested by Prof. Meldola to Prof. S. P. Thompson, and the latter had brought the subject before Section C. It had been suggested that the method might be found generally useful for investigating the course of underground waters, as a very small trace of the dye produced an intense green fluorescence.

Mr. De Rance, who also represented Section C, remarked on the work of the Underground Waters Committee, that its objects were to study underground water with a view to supply from wells and springs. Questions were asked respecting the quality, quantity, and level of the water. The Committee wished for records of water-level extending over long periods of time, and especially to secure old records. The work of the Coast-erosion Committee had been carried on with important results, and much information had been derived from a study of old charts. The Committee on Erratic Blocks, of which Dr. Crosskey was the Secretary, was appointed in 1871 with the object of recording the exact positions of the more important boulders, and of entering these positions on the Ordnance maps. It was important to have a microscopical examination made of sections of chips from the boulders, so that their probable sources might be ascertained. Another point was that the boulders should not be left to the mercy of the stone-breaker, but should be preserved.

Prof. Meldola stated that he had been requested by Dr. Crosskey to thank the Corresponding Societies for the aid they had already given, and to express the hope that their assistance would be continued.

SECTION D.

Phenological Observations.—Mr. Symons introduced this subject, which, he said, might perhaps be considered to have originated with Gilbert White, but received little attention in England until 1874, when the Meteorological Society obtained the assistance of delegates from several Natural History Societies, who held a number of meetings and drew up a Report. Plants, insects, and birds were referred respectively to the Rev. T. A. Preston, Mr. McLachlan, and Prof. Newton. Of plants, 71 species were recommended for observation, of insects 8, and of birds 17. From 1875 to 1878 the Rev. T. A. Preston prepared, and the Royal Meteorological Society printed, annual Reports embodying the results obtained. Mr. Preston finding it impossible to continue the work, Mr. E. Morley took it up and prepared the Report for 1889. On his suggestion the list had now been reduced to 13 plants, 3 insects, and 5 birds, and the Council of the Royal Meteorological Society desired to enlist as many observers as possible, and to obtain the assistance of the Corresponding Societies of the British Association.

A discussion ensued as to the suitability for observation of the species selected. In concluding it, Mr. Symons said that he had brought the matter forward more as a meteorologist than as a naturalist, and he thanked the delegates for their suggestions.

SECTION E.

Teaching of Geography in Elementary Schools.—Mr. Sowerbutts said that he had undertaken to draw up for Section E a Report on this subject with reference to the action of local authorities, in order to make known how far the Government grant for technical education or allied purposes was made use of for the teaching of geography, and he asked the delegates to assist him by sending in School Board Reports, &c.

SECTION H.

Committee of Aid for Anthropological Excavations.—Dr. Garson called attention to the existence of a Committee of Aid formed by the Anthropological Institute for the purpose of aiding by direction or otherwise the exploration of ancient remains, the Chairman of this Committee being General Pitt-Rivers, the Inspector of Ancient Monuments. Local societies, he said, would find it to their advantage if they would report to this Committee when they were desirous of undertaking explorations.

Prehistoric Remains Committee.—Mr. J. W. Davis said that this Committee, of which he was Secretary, wanted a record of everything that had reference to prehistoric man, his dwellings, implements, pottery, &c.

A discussion then took place with reference to the best method of imparting to the Corresponding Societies through their delegates a knowledge of what had taken place at the Conferences. Mr. Hopkinson suggested that each delegate should read a paper before his Society, giving an account of the work taken up by the various Committees, and that this paper should be published by that Society, so as to be accessible to every member of it. He distributed amongst the delegates a paper on the work of the Committees of the Association which he had brought before the Hertfordshire Natural History Society. Another question raised was the advisability of in some way bringing into relationship with the British Association certain societies which did not come up to the standard of excellence requisite for enrolment as Corresponding Societies.

On the motion of Prof. Lebour, seconded by Mr. J. W. Davis, a vote of thanks was passed to Mr. Symons, Chairman of the Conference, and to Prof. Meldola, Secretary.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. Love, Fellow of St. John's College, has been elected Chairman of the Examiners for the Mathematical Tripos, Part I.

Prof. Darwin, Prof. J. J. Thomson, Mr. Pendlebury, St. John's, and Mr. Lachlan, Trinity, have been appointed Examiners for the second part of the Mathematical Tripos.

Mr. E. A. Parkyn, Christ's, and Mr. M. C. Potter, Peterhouse, have been appointed Lecturers in Science at affiliated lectu re-centres.

Scholarships and Exhibitions in Natural Science will be open for competition to non-members of the University in December and January next at the following Colleges: King's, Jesus, Christ's, St. John's, Trinity, Emmanuel, and Sidney Sussex (see *Cambridge University Reporter*, November 18, 1890, p. 237).

SOCIETIES AND ACADEMIES.

LONDON.

Royal Meteorological Society, November 19.—Mr. Baldwin Latham, President, delivered an address on "The Relation of Ground Water to Disease." The pages of history show that when the ground waters of our own or other countries have arrived at a considerable degree of lowness, as evidenced by the failure of springs and the drying up of rivers, such periods have always been accompanied or followed by epidemic disease. In all probability ground water in itself, except under conditions where it is liable to pollution, has no material effect in producing or spreading disease. As a rule, it is only in those places in which there has been a considerable amount of impurity stored in the soil that diseases become manifest, and the most common modes by which diseases are, in all probability, disseminated, are by means of the water supplies drawn from the ground, or by the elimination of ground-air into the habitations of the people. It is found that the periods of low and high water mark those epochs when certain organic changes are taking place in the impurities stored in the ground, which ultimately become the cause and lead to the spread of disease. Mr. Latham defines "ground water" as all water found in the surface soil of the earth's crust, except such as may be in combination with the materials forming the crust of the earth. It is usually derived from rainfall, by percolation; and it is also produced by condensation. In dry countries, ground water is principally supplied by the infiltration from rivers, as, for example, in the Delta of the Nile. The absence of water passing into the ground for a long period naturally leads to the lowering of the free ground water-line, and may lead to the drying of the ground above the water-line; and it is curious to note, with reference to small-pox, that the periods marking the epochs of this disease are those in which there has been a long absence of percolation, and a consequent drying of the ground preceding such epidemics. On the other hand, small-pox is unknown at such periods as when the ground has never been allowed to dry, or is receiving moisture by condensation or capillarity. The study of underground water shows that certain diseases are more rife when waters are high in the ground, and others when the water is low. The conditions that bring about and accompany low water, however, have by far the most potential influence on health, as all low water years are, without exception, unhealthy. As a rule, the years of high water are usually healthy, except, as often happens, when high water follows immediately upon marked low water, when on the rise of the water an unhealthy period invariably follows. Mr. Latham has found that those districts which draw their water supplies direct from the ground, are usually more subject to epidemics and disease than those districts in which the water supply is drawn from rivers supplied from more extended areas, or from sources not liable to underground pollution. In the case of Croydon, one portion of the district (under three-fourths) is supplied with water taken direct from the ground, whilst the remaining portion is supplied with water from the River Thames. It is curious to note that even so recently as 1885 the zymotic death-rate in the districts supplied with underground water was twice as great as in that part of the district supplied from the Thames; and in this particular year forty-one deaths from small-pox occurred in the district, not one of which was recorded outside the district supplied by the underground water. Mr. Latham, in his address, dealt largely with zymotic diseases as affected by ground water, and showed that cholera ordinarily breaks out when there is the least ground water: a high air and ground temperature is also necessary for its development, and as a rule the low-lying districts are favourable to the production of these high temperatures. Small-pox is almost always preceded by a long period of dryness of the ground, as measured by the absence of percolation. Typhoid fever is most prevalent after a dry period, and the first wetting of the ground or percolation from any cause takes place. The condition essential to the development of diphtheria is a damp state of the ground marked by extreme sensitiveness to percolation of rain. Scarlet fever follows the state of the dryness of the ground, which is essential for its development, and it occurs in the percolation period. The conditions that precede small-pox are those favourable for the development of scarlet fever, and, like small-pox, the dampness of the ground for any considerable period in any particular locality, may check its development or render it less virulent, and it is most rife in low water years. Measles are least prevalent at the low water periods, and mostly rife at and near high water periods. Whooping-cough follows the percolation period in its incidence, increasing with percolation, and diminishing as the waters in the ground subside. Diarrhœa is generally more prevalent in a low water year than in other years; that is, with a very much colder temperature in a low water year there is a very much higher death-rate from this disease. Mr. Latham finds that the general death-rate of a district is amenable to the state of the ground water, years of drought and low water being always the most unhealthy.

Geological Society, November 12.—Dr. A. Geikie, F.R.S., President in the chair.—The President referred to the sad loss the Society had sustained since the last meeting, through the death of the late Foreign Secretary, Sir Warington W. Smyth, F.R.S.—The President reported that Mr. L. Belinfante had been temporarily appointed by the Council to the office of Assistant-Secretary.—The following communications were read:—On the porphyritic rocks of the Island of Jersey, by Prof. A. De Lapparent, Foreign Correspondent of the Society. (Communicated by the President.) The author had some years ago described as Permian a series of porphyritic rocks, of which specimens had been sent to him from Jersey. He had since been led to believe that this view of their age, arrived at from what he knew of similar rocks in France, was erroneous, and in a recent visit to the island had satisfied himself that the English observers who had assigned to these rocks a much higher antiquity were in the right. He now found that

the igneous rocks in question underlie the Rozel conglomerate, which must be placed at the very base of the Silurian formations. He reserved his detailed statement for a communication to the Geological Society of France; his present object being to do justice to English geologists, whose views he had formerly opposed.—On a new species of *Trionyx* from the Miocene of Malta, and a Chelonian scapula from the London Clay, by R. Lydekker.—Notes on specimens collected by W. Gowland, in the Korea, by Thomas H. Holland, of the Geological Survey of India, late Berkeley Fellow of the Owens College. (Communicated by Prof. J. W. Judd). The southern half of Korea traversed by Mr. Gowland is of a hilly character. The rocks forming the hills are chiefly crystalline schists—gneisses with graphite, garnet, dichroite, and fluor occurring in considerable abundance; and the whole group is probably part of the great Archæan mass of North-East China. The author describes these metamorphic rocks in detail. Stratified rocks, probably of Carboniferous age, lie unconformably upon the schists in the south-eastern part of the peninsula, and petrographical notes of these are given in the paper. Through the crystalline schists and stratified rocks various igneous rocks have been erupted as dykes or in large masses. Amongst these the most conspicuous rock is granite. Biotite- and muscovite-granite are most widely distributed, and in places are cut by dykes of eurite and veins of quartz and pegmatite. The more basic class of rocks is represented by diorites, propylites, andesites, basalts, dolerites, and gabbros. Interesting cases of the gradual passage between the so-called intermediate and basic rocks are found, and various stages in the devitrification and decomposition of andesitic lavas represented. These are described in detail by the author, and compared with similar cases in other regions; and full descriptions of the intrusive rocks are furnished. There are now no active volcanoes; and there is a notable lack of mineral wealth in the southern part of the Korea. Prof. Judd spoke of the value of Mr. Gowland's geographical and geological discoveries, and the enthusiasm with which Mr. Holland had applied himself to the work of examining the specimens brought home, and he considered that the work would prove an important contribution to science. Several points about which difficulties had arisen by examination of European rocks had light thrown upon them by the Korean specimens. The President felt that the Society would agree with him in considering the Geological Survey of India fortunate in securing a petrologist like Mr. Holland.—Further notes on the stratigraphy of the Bagshot Beds of the London Basin (north side), by the Rev. A. Irving.

Mathematical Society, November 13.—J. J. Walker, F.R.S., in the chair.—The Chairman informed the members of the loss the Society had recently sustained by the death of Dr. A. J. Ellis, F.R.S., who was elected a member on June 19, 1865, and had served on the Council during the sessions 1866–67, 1867–68. He gave a brief sketch of Dr. Ellis's contributions to mathematics and other subjects. He next sketched in some detail the numerous contributions made to mathematical physics by Lord Rayleigh, F.R.S., dwelling more particularly upon those memoirs which had led the Society, as announced at the June meeting, to award him the De Morgan Memorial Medal. The medal having been presented, Lord Rayleigh simply thanked the Society for their gift.—The new Council having been duly elected, the new President (Prof. Greenhill, F.R.S.) called upon Mr. Walker to read his address "On the Influence of Applied on the Progress of Pure Mathematics." The author was asked to print the paper in the Proceedings, on the motion of Mr. A. B. Kempe, F.R.S., seconded by Lord Rayleigh.—The following communications were made:—Spherical harmonics of fractional order, by R. A. Sampson.—Proofs of Steiner's theorem relating to circumscribed and inscribed conics, by Prof. Mathews.—On an algebraic integral of two differential equations, by R. A. Roberts.—Some geometrical constructions, by Oscher Ber (communicated by Prof. Hill).—On the analytical representation of heptagrams, by Prof. L. J. Rogers.

Zoological Society, November 18.—Dr. Mivart, F.R.S., in the chair.—Mr. F. Menteith Ogilvie exhibited and made remarks on a specimen of the Red-headed Flycatcher obtained in Norfolk.—Prof. F. Jeffrey Bell exhibited an example of the Cotton-spinner (*Holothuria nigra*), taken off the west coast of Ireland, and sent for determination by Prof. Herdman.—Mr. G. A. Boulenger exhibited a series of skulls belonging to *Distira cyanocincta* and *Chelone midas*.—Mr. G. A. Boulenger read a paper upon the Reptiles and Batrachians of Barbary (Morocco, Algeria, Tunisia), based chiefly upon the notes and collections made in 1880–84 by M. Fernand Lataste.—A second paper by Mr. G. A. Boulenger contained remarks on the Chinese Alligator.—A communication was read from the Rev. O. P. Cambridge, F.R.S., giving an account of some new species and two new genera of Araneidea, mostly collected in South Africa by the Rev. Nendick Abraham.—Mr. Smith Woodward read a paper on some Upper Cretaceous Fishes of the family Aspidorhynchidæ. He offered a detailed description of *Belonostomus comptoni*, from Brazil, and defined a new genus (*Apateopholis*) from Syria. The latter is remarkable as being the only physostomous fish hitherto described exhibiting a spinous armature of the preoperculum.—Mr. G. C. Champion read a paper on the Heteromerous Coleoptera collected by Mr. Bonny at the Yambuya Camp, Aruwimi Valley.

PARIS.

Academy of Sciences, November 17.—M. Hermite in the chair.—Ed. Phillips, by M. H. Léauté. The deceased mathematician was born at Paris on May 21, 1821, and died on December 14, 1889. An account is given of his many works in mechanics and mathematical physics.—On the name of bronze, by M. Berthelot. The author quotes the following from a work of the time of Charlemagne: "Compositio brandisii: eramen partes II., plumbi parte I., stagni parte I.," that is to say, bronze is composed of two parts of copper, one of lead, and one of tin. This appears to confirm the view that the name of bronze is derived from that of the town of Brundusium, or βρεντήσιον, especially as many bronze vessels have been found marked *ars Brundusinum*.—Remarks on some acoustical sensations provoked by certain quinine salts, by M. Berthelot. The author describes certain humming noises that he hears after the ingestion of lactate.—A Chaldæan astronomical annual used by Ptolemy, by M. J. Oppert. A series of lunar and planetary observations have been found in the British Museum among the cuneiform tablets. These have been deciphered, and prove to be among the oldest and most detailed we possess. The phenomena recorded on them took place in the year 522 B.C., and are described in an exceedingly minute manner. An account is given of the results obtained by an investigation into these cuneiform inscriptions, and their bearing upon the dates of certain events.—On the annual variation in the latitude caused by the differences in refractional effects which result from atmospheric tides, by Dom Lamey. The tidal effect of the sun and moon upon the atmosphere is given as a probable cause of the annual variation in latitude.—Rapid development of a solar prominence, by M. Jules Fényi. The prominence appeared on the western edge of the sun, from heliographic latitude $-20°\,13'$ to $-30°\,21'$, on October 6, at 1h. 18m. Kalocsa mean time. In about half an hour the eruption had reached a height of 327″—that is, 235,900 kilometres.—On one of M. Picard's theorems, by M. Gustaf Kobb.—Note on the construction of plans from views obtained at elevated points in the atmosphere, by M. A. Laussedat. A method is described by means of which photographic views obtained from balloons may be reduced to plan.—Researches in thermo-electricity, by MM. Chassagny and H. Abraham. The authors have already shown that the electromotive forces of thermo-electric couples, of which the junctions are maintained at 0° and 100° respectively, may be determined to $\frac{1}{1000}$ of their value. They find that the following formula, though not representing their measures with entire accuracy, is sufficient to give the tenth of a degree Centigrade in the interval 0° to 100°. The formula

$$E_0^t = \frac{at + bt^2 + ct^3}{t + 273},$$

where $a = 10^{-3} \cdot 3{\cdot}56604$, $b = 10^{-6} \cdot 8{\cdot}3827$, $c = -10^{-8} \cdot 3{\cdot}265$, t = temperature, and E = electromotive force. The value of E_0 at 100° = 0·0010932 volts with an iron-copper couple. The following is a comparison of observed and calculated results at different temperatures—

Temperature.	Electromotive forces. Observed volts.	Calculated volts.
65°·13	0·0007656 ...	0·0007654
32°·49	0·0004043 ...	0·0004045
15°·48	0·0001981 ...	0·0001980

—On the periodicity of undulatory pressures produced by the combustion of explosives in a closed vase, by M. P. Vieille.

The undulations set up at the extremities of a receiver 1 metre long have been photographically registered by the side of time signals. The extremely accurate results obtained indicate that the method may be used for the study of the phenomena of the propagation of waves in conditions of gaseous condensation and temperature above those as yet investigated.—On the electrical resistance of bismuth in a magnetic field, by M. A. Leduc. The author develops a formula which allows the calculation of the resistance of a wire of bismuth placed in a magnetic field at a certain temperature, in terms of its resistance at 0° outside the field.—On the β-pyrazol-dicarbonic acids, by M. Maquenne. Aldehydes react with dinitrotartaric acid in presence of ammonia, giving rise to monobasic acids which, on heating, form β-pyrazol-dicarbonic acids of the general formula

$$\begin{matrix} CO_2H—C—N \\ | \quad\quad \diagdown\!\!\diagup CR. \\ CO_2H—C—NH \end{matrix}$$

Furfural does not act in the same manner, the body obtained being

$$\begin{matrix} CO_2H—C(OH)—N=CH—C_4H_3O \\ | \\ CO_2H—C(OH)—N=CH—C_4H_3O. \end{matrix}$$

The sugars with aldehyde reactions give no definite combination with nitrotartaric acid.—On a phenol acid derived from camphor, by M. P. Cazeneuve.—Note upon active amylic derivatives, by M. Philippe A. Guye.—On the saponification of halogen organic compounds, by M. C. Chabrié.—The author forms the fluorides by the sealed tube method, and saponifies these bodies by means of milk of lime, *e.g.*

$$C_2H_4F_2 + Ca(OH)_2 = \underbrace{C_2H_6O_2}_{\text{Glycol}} + CaF_2.$$

A reaction of the halogen compounds with B_2O_3 is also indicated.—On a gaseous antiseptic, its action upon the pyogenous bacteria of the urinary infection, by M. C. Chabrié.—On the fixation of gaseous nitrogen by the Leguminosæ, by MM. Th. Schlœsing and Em. Laurent.—On the microbe of the nodosities of Leguminosæ, by M. Em. Laurent.—On some transitory characters presented by *Chelmo rostratus*, Linn., by M. Léon Vaillant.—On the sexual dimorphism of *Enterocola fulgens*, by M. Eugène Canu.—On the sexual differences of *Lepadogaster bimaculatus*, Flem., by M. Frédéric Guitel.—On the antagonistic molecular forces which are produced in the cellular nucleus, and on the formation of the nucleiform membrane, by M. Ch. Degagny.—On the origin of the terraces (*rideaux*) in Picardy, by M. H. Lasne.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, NOVEMBER 27.

ROYAL SOCIETY, at 4.30.—On the Homology between Genital Ducts and Nephridia in the Oligochæta: F. E. Beddard.—The Patterns in Thumb and Finger Marks; on their Arrangement into Naturally Distinct Classes, the Permanence of the Papillary Ridges that make them, and the Resemblance of their Classes to Ordinary Genera: F. Galton, F.R.S.—Preliminary Note on the Transplantation and Growth of Mammalian Ova within a Uterine Foster-Mother: W. Heape.—The Conditions of Chemical Change between Nitric Acid and Certain Metals: V. H. Veley.—The Variations of Electromotive Force of Cells consisting of Certain Metals, Platinum, and Nitric Acid: G. J. Burch and V. H. Veley.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Efficiency of Secondary Cells; "On the Chemistry of Secondary Cells: Prof. W. E. Ayrton, F.R.S., and E. W. Smith.

FRIDAY, NOVEMBER 28.

PHYSICAL SOCIETY, at 5.—Notes on Secondary Batteries: Dr. Gladstone and W. Hibbert.—An Illustration of Ewing's Theory of Induced Magnetism: Prof. S. P. Thompson.

AMATEUR SCIENTIFIC SOCIETY, at 8.—Aquatic Microscopical Life (with Lantern Illustrations): J. D. Hardy.

SUNDAY, NOVEMBER 30.

SUNDAY LECTURE SOCIETY, at 4.—The Natural Growth of Religion in India: Sir A. C. Lyall, K.C.B., K.C.I.E.

MONDAY, DECEMBER 1.

SOCIETY OF ARTS, at 8.—Gaseous Illuminants: Prof. Vivian B. Lewes.

ROYAL MICROSCOPICAL SOCIETY, at 8.—*Conversazione.*

VICTORIA INSTITUTE, at 8.—On the Geological History of Egypt: Prof. Hull, F.R.S.

ROYAL INSTITUTION, at 5.—General Monthly Meeting.

TUESDAY, DECEMBER 2.

ZOOLOGICAL SOCIETY, at 8.30.—On the Antelopes of Nyassa-Land; Richard Crawshay.—On the Suspension of the Viscera in the Batoid Hypnos subnigrum: Prof. G. B. Howes.—Notes on the Pectoral Fin-skeleton of the Batoidea and of the Extinct Genus Chlamydoselache: Prof. G. B. Howes.—On the Presence of Pterygoid Teeth in a Tailless Batrachian (Pelobates cultripes), with Remarks on the Localization of Teeth on the Palate in Batrachians and Reptiles: G. A. Boulenger.

ESSEX FIELD CLUB (at Loughton), at 7.—Some Notes on Dipsacus sylvestris and D. pilosus and their Natural Relationship: J. French.—The Butterflies of Essex: Edward A. Fitch.—The Land and Fresh-water Mollusca occurring in the Neighbourhood of Bishop's Stortford: Edwin G. Ingold.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Ballot for Members.—The Vibratory Movements of Locomotives: Prof. John Milne, F.R.S., and John McDonald. (Discussion.)—The Sukkur Bridge at Benares: F. E. Robertson.—The New Chittravate Bridge, Madras Railway: E. W. Stoney.

WEDNESDAY, DECEMBER 3.

SOCIETY OF ARTS, at 8.—The Chicago Exhibition, 1893: James Dredge.

ENTOMOLOGICAL SOCIETY, at 7.—On the Conspicuous Changes in the Markings and Colouring of Lepidoptera, caused by subjecting the Pupæ to Different Temperature Conditions: Frederic Merrifield.—Notes on the Lepidoptera collected in Madeira by the late T. Vernon-Wollaston: George T. Baker.—A Monograph of the Lycænoid Genus Hypochrysops, with Descriptions of New Species: Hamilton H. Druce.—The Life-History of the Hessian Fly: Frederick Enock.

THURSDAY, DECEMBER 4.

LINNEAN SOCIETY, at 8.—On the Genus of Orchid Brownheadia: H. N. Ridley.—On the Botany of Kandahar: J. H. Lace.—Botanical Visit to Auckland Isles: Thos. Kirk.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—On the Volumetric Estimation of Tellurium: Dr. Branner.

FRIDAY, DECEMBER 5.

GEOLOGISTS' ASSOCIATION, at 8.—Report on the Microscopical Examination of some Samples of London Clay from the Excavations for the Widening of Cannon Street Railway Bridge, 1887: C. Davies Sherborn and H. W. Burrows.—A Short Visit to Ingleton and to Filey Brigg (showing how a Dangerous Reef was converted into a Perfect Breakwater by an Ancient Race): Edwin Litchfield.

CONTENTS.